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BACKGROUND UNCERTAINTY AND THE DEMAND FOR INSURANCE AGAINST INSURABLE RISKS

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Abstract

Theory suggests that people facing higher uninsurable background risk buy more insurance against other risks that are insurable. This proposition is supported by Italian cross-sectional data. It is shown that the probability of purchasing casualty insurance increases with earnings uncertainty. This finding is consistent with consumer preferences being characterised by decreasing absolute prudence.

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1. Introduction

In real life individuals face multiple risks that, often independently of each other, can adversely affect their resources. Illness, theft, unemployment, fires and floods, earthquakes, motor vehicle accidents and changes in the prices of assets are among the many shocks that can deplete individuals' endowments. Due to market incompleteness, however, only a few of these risks can be insured against; the others must be borne in full. In these circumstances it is likely that there will be spillover effects even across independent risks: if what concerns individuals is their overall exposure to uncertainty, they may cut the amount of avoidable risks to offset unavoidable risks, such as that arising from shocks to human capital.

One possible consequence of independent background uncertainty - i.e. uncertainty in the initial endowment - could be a reduction in holdings of risky securities; another could be an increase in self-protection or the purchase of more insurance against those risks that are insurable. Thus the presence of background uncertainty can alter agents' risk-taking behavior, inducing them to behave in a more risk-averse manner when faced with other independent but avoidable risks. In spite of this obvious observation, only very recently has the theoretical literature on insurance focused on cases where uncertainty springs from more than one source.[1]

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[1] Exceptions are Turnbull (1983) and Doherty and Schlesinger (1983a) who show that the results of Mossin (1968) on optimal insurance do not generally hold when the insured is faced with multiple risks and insurance markets are incomplete, and Doherty and Schlesinger (1983b) who extend the analysis of deductible insurance to the case where initial wealth is random. More recently Meyer (1992) and Dionne and Gollier (1992) have developed general methods to study the effects of increases in risk on the level of the coinsurance rate when there are multiple sources of risk, some insurable and some not. Their analysis is limited to comparative static responses to changes in the probability distribution of the insurable loss.

Kimball (1993) and Eeckhoudt and Kimball (1992) show that if preferences exhibit decreasing absolute risk aversion and prudence or if temperance exceeds prudence (Gollier and Pratt, 1996), the addition of a zero mean, uninsurable risk to initial wealth increases the demand for insurance against insurable risks even if the two types of risk are independent. The intuition is that independent risks are to some extent substitutes, so that insuring one offers some attenuation of the others as well. Elmendorf and Kimball (1991) and Duffie and Zariphopoulou (1993) explore the implications of this proposition for the determinants of portfolio choices when labor income is uncertain and show that when agents face uninsurable risks they also reduce the demand for risky assets. Guiso, Jappelli and Terlizzese (1996) find that this proposition is supported by Italian cross-sectional data: the portfolio share of risky securities is inversely related to proxies for income risk.

On the empirical side, few studies analyze the determinants of the demand for insurance and none, to our knowledge, the effect of other uninsurable risks on the insurance decision. In this paper we use Italian cross-sectional data drawn from the 1989 Survey of Households Income and Wealth (SHIW) to study the response of the consumer's demand for insurance to a subjective measure of earnings uncertainty, taken as a proxy for background risk.

To clarify the effect of background risk on the demand for insurance, Section 2 summarizes the effect of background risk on optimal insurance. The data are set out in Section 3 and the empirical tests are presented in Section 4. The findings suggest that the demand for insurance is positively affected by background risk. The results are especially strong for insurance decisions, weaker for insurance amounts. In the group with low expected income variance the average predicted probability of purchasing insurance is 13.2 percent; the probability increases to 19.6 percent for the group with high expected income variance. We also find that the effect of income risk on the demand for insurance falls with the level of households' resources.

2. Theory and model specification

2.1 *The standard insurance model*

We illustrate the effect of background uncertainty on the demand for insurance mainly drawing on recent theoretical findings. Consider a model in which the household faces two independent risks. As in the classical insurance model, one risk is insurable; but contrary to the classical model, the other is not. Suppose that $\tilde{y} = y + \varepsilon$ is the initial uncertain endowment (i.e. the uninsurable background risk), where ε is a zero mean disturbance term with variance σ_{ε}^2. Let p be the probability of an insurable loss of size L and $u(\cdot)$ the utility of consumption. If the random endowment is independent of the insurable loss, the consumer optimization problem is

$$(1) \qquad \max_{a} pEu(\tilde{y} - (1-a)L - a\Pi) + (1-p)Eu(\tilde{y} - a\Pi)$$
$$s.t. \quad (i)\ \Pi = \mu pL$$
$$(ii)\ a \geq 0$$

where Π denotes the full insurance premium and a the coinsurance rate, so that $a\Pi$ is the total insurance premium. E denotes the expectation operator and expectations are taken over $\tilde{y}$. The first constraint states that the premium is proportional to the expected value of the loss; μ is the mark-up over the fair insurance premium (the case $\mu=1$).[2] The second constraint states that the agent cannot "go short" on insurance. This problem is similar to the one analyzed by Eeckhoudt and Kimball (1992).

Letting $\Im = a\Pi$, the optimization problem reduces to

$$\text{(2)} \qquad \max_{\Im} \; pEu[\tilde{y} - L + \left(\frac{1-\mu p}{\mu p}\right)\Im] + (1-p)Eu(\tilde{y} - \Im)$$
$$\text{s.t. } \Im \geq 0$$

where $(1-\mu p)\Im / \mu p$ is the net indemnity received by the consumer in the event of a loss. To study the effect of background risk on the demand for insurance consider first the case of no background risk, i.e. $\tilde{y} = y$. Let $\Im_c$ be the optimal level of insurance purchased when the endowment is certain, i.e. the solution of the first order condition

$$\text{(3)} \qquad pu'(y - L + \frac{(1-\mu p)}{\mu p}\Im)(\frac{1-\mu p}{\mu p}) \leq (1-p)u'(y - \Im) .$$

Standard results in insurance theory imply that if the utility function is concave, the consumer does not insure ($\Im_c = 0$) when the mark-up μ exceeds a given threshold $\bar{\mu}$; otherwise the problem has an interior solution ($\Im_c > 0$).[3]

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[2] The mark-up may be due to transaction costs. Thus, a mark-up is not necessarily inconsistent with competitive insurance markets. Italian casualty insurance companies generally set premiums by multiplying fair premiums by a mark-up to cover intermediation costs and guarantee a "normal profit". For this reason we model a proportional mark-up. However, none of the main results of this section depend on this assumption.

[3] The condition for an interior solution is $u'(y-L) > \frac{\mu(1-p)}{1-\mu p}u'(y)$. Since the concavity of u( ) implies $u'(y-L) > u'(y)$, the condition holds if $\mu < \bar{\mu}$, where $\bar{\mu} = \frac{u'(y-L)}{pu'(y-L)+(1-p)u'(y)} > 1$.

Further, if $\mu=1$ the individual insures fully, independently of the degree of absolute risk aversion; if instead $\mu>1$, the amount of insurance purchased increases with risk aversion.

2.2 *The effect of background risk on insurance demand*

The last result can be used to show that the introduction of background risk can, under certain conditions, increase optimal insurance. Let $v(y) = Eu(y+\varepsilon)$ be the derived utility function obtained integrating over ε, the random component of the initial endowment. Problem (2) can then be written as

$$\text{(4)} \qquad \max_{\Im} \; pv[y - L + \left(\frac{1-\mu p}{\mu p}\right)\Im] + (1-p)v(y-\Im) \qquad \text{s.t. } \Im \geq 0$$

which is formally equivalent to the problem in which the initial endowment is certain. Let $\Im^*$ be the solution of the first order condition when the initial endowment is uncertain

$$\text{(5)} \qquad pv'(y - L + \frac{(1-\mu p)}{\mu p}\Im)(\frac{1-\mu p}{\mu p}) \leq (1-p)v'(y-\Im)\,.$$

Eeckhoudt and Kimball (1992) show that if $u(\cdot)$ exhibits decreasing absolute risk aversion and decreasing absolute prudence, $v(\cdot)$ is strictly more risk averse than $u(\cdot)$, implying $\Im^* \geq \Im_c$.[4] The inequality is strict if $\Im_c > 0$, or if $\Im_c = 0$ and background risk is sufficiently large.

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[4] The proof is straightforward. Define Kimball's precautionary premium, $\psi(y,\varepsilon)$, from $u'(y-\psi(y,\varepsilon)) = Eu'(y+\varepsilon)$; since $v'(y) = Eu'(y+\varepsilon) = u'(y-\psi)$ and $v''(y) = (1-\frac{d\psi}{dy})u''(y-\psi)$, it follows that

The effect of background risk on insurance demand is shown in Figure 1. In each of the three panels, we denote as *LL* the marginal benefit from raising coverage in the event of a loss (the left-hand side of equation 3), and as *NN* the marginal cost from raising coverage in the event of no loss (the right-hand side of 3). The shape of the curves reflects the assumption that the individual is prudent, i.e. that marginal utility $u'(\cdot)$ is convex. In the absence of background risk, $\Im_c$ is determined at the intersection of the two curves.

Consider now introducing an independent, zero mean, background risk ε. Let $w_L = y - L + \frac{1 - \mu p}{\mu p}\Im_c$ and $w_N = y - \Im_c$ denote, respectively, the level of resources in the two states when the consumer insures optimally in the absence of background risk. Three cases are possible, depending on the value of μ.

If insurance is fair, $\mu=1$ and the consumer insures fully against the insurable risk, i.e. $\Im_c = pL$. This implies $w_L = w_N$, so that expected marginal utility is $Eu'(y - pL)$ in both states. Since the introduction of the background risk raises expected marginal utility equally in both states, the two curves in panel (a) of Figure 1 shift upwards by the same

$$-\frac{v''(y)}{v'(y)} = -(1-\frac{d\psi}{dy})\frac{u''(y-\psi)}{u'(y-\psi)} > -\frac{u''(y-\psi)}{u'(y-\psi)} > -\frac{u''(y)}{u'(y)}$$

The first and the last terms are the Arrow-Pratt measures of absolute risk aversion of the derived and initial utility functions, respectively. Decreasing prudence implies $\frac{d\psi}{dy}<0$, and the first inequality follows; the second inequality is an implication of decreasing absolute risk aversion.

amount. Hence, the optimal amount of insurance in the presence of background risk, $\Im^*$, is also unchanged at pL.[5]

If instead $1<\mu<\bar{\mu}$, optimal insurance when the endowment is certain provides only partial coverage ($0<\Im_c<pL$). Thus, the total amount of resources in the loss state, w_L, is smaller than in the no-loss state, w_N. The two curves shift again upwards in response to background risk (panel b). However, if preferences display decreasing absolute risk aversion and decreasing absolute prudence, background risk raises expected marginal utility in the loss state proportionally more than in the no-loss state. Hence, the shift of the *LL* curve exceeds that of the *NN* curve and $\Im^*$ increases.[6]

Finally, panel (c) shows that if μ exceeds the threshold $\bar{\mu}$ (defined in footnote 3) the optimal level of insurance is negative; but given the no "short sales" constraint, no insurance is initially purchased. Since the introduction of background risk raises $\bar{\mu}$, it also raises the possibility that the insurance will be purchased, for the same reason as in the previous case. Note that the consumer switches to insurance purchase only if background risk is sufficiently large.

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5 If $\mu = 1$ full insurance is optimal even if the initial endowment is random but independent of the insurable risk. In fact, from equation (5) $Eu'(\bar{y} - L + (\frac{1-p}{p})\Im) = Eu'(\bar{y} - \Im)$; this holds if $y_i - L + (\frac{1-p}{p})\Im = y_i - \Im$ for all i, implying $\Im^* = pL$. For $\Im > pL$, the left-hand side of the above condition is smaller than the right-hand side (larger if $\Im < pL$).

6 Doherty and Schlesinger (1983a) show that if $\mu > 1$ partial coverage is optimal even if the two risks are negatively correlated, although it is not necessarily invariant to the degree of correlation or to the level of background risk.

To summarize, if insurance is offered at unfair terms and preferences display decreasing risk aversion and decreasing prudence the introduction of an independent, zero mean, uninsurable risk increases the demand for insurance against the insurable risk. The intuition is that adding an independent risk increases the expected marginal benefit from raising coverage conditional on "bad" realizations of the insurable risk relatively to the marginal cost conditional on "good" realizations. This, in turn, increases the probability of purchasing insurance against the insurable risk and the amount of insurance purchased. One can also show that if risk aversion and prudence are sufficiently convex, the effect of background risk on insurance demand falls with the level of the certain endowment.[7] This places additional restrictions on preferences: assuming decreasing prudence, a necessary condition for prudence to be convex is that the degree of absolute temperance, as defined by Kimball (1992), falls with y.[8] This implies that the effect of endowment risk on insurance is likely to depend on the level of resources.

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7 A proof is available upon request. Gollier and Pratt (1996) argue that the convexity of absolute risk aversion should be regarded as a natural assumption, "since it means that the wealthier an agent is, the smaller the reduction in risk premium following an increase in wealth". On the same grounds, convexity of absolute prudence should also be viewed as a natural property of preferences. In fact, this implies that the precautionary premium of a given risk falls with wealth. Kimball (1992) provides intuitive arguments in favor of decreasing absolute prudence.

8 Let $T(y) = -u''''(y)/u'''(y)$ denote the degree of absolute temperance, $P(y) = -u'''(y)/u''(y)$ the degree of absolute prudence and $R(y) = -u''(y)/u'(y)$ the degree of absolute risk aversion. The convexity of $P(\cdot)$ requires that $(Q-P)/(T-P) > 2P/T$, where $Q = -u'''''/u'''' > T$ if temperance is decreasing and $T > P$ if prudence is decreasing. Convexity of absolute risk aversion requires that a similar condition holds, i.e. $(T-R)/(P-R) > 2R/P$, where $P > R$ if absolute risk aversion is decreasing.

2.3 *Extensions*

We have discussed the effect of background risk on insurance demand starting from a situation where none is present. However, adding a zero mean independent risk to a risky endowment also increases $\Im^*$. This only requires defining $u(y)$ as a derived utility function obtained integrating with respect to a zero-mean shock, η, to the initial endowment, y. Using the same argument as in footnote 4, the addition of a zero mean independent risk, ε, to the risky endowment, $y+\eta$, increases the insurance premium if prudence and absolute risk aversion are decreasing.[9]

Decreasing absolute risk aversion and prudence are sufficient for individuals to become more risk averse when confronted with an increase in background risk. The condition that absolute prudence is decreasing can be weakened. Gollier and Pratt (1996) elaborate on the notion of "proper risk aversion" (Pratt and Zeckhauser, 1987) and establish necessary and sufficient conditions under which adding a small, unfair, independent risk to wealth induces more risk-averse behavior. This requires that absolute temperance, $T(\cdot) = -u''''(\cdot)/u'''(\cdot)$, exceed absolute risk aversion, a weaker condition than decreasing prudence.[10]

The comparative static of increased background risk is further generalized by Eeckhoudt, Gollier and Schlesinger (1996), who extend the analysis to general first and second

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[9] This result holds under the weaker condition $E(\varepsilon|\tilde{y}) = 0$ for all y.

[10] Decreasing prudence requires that temperance be larger than prudence which, in turn, is larger than risk aversion if risk aversion is decreasing. Thus, the condition specified by Gollier and Pratt (1996) may hold even if temperance is lower than prudence. An equivalent condition is set out by Franke, Stapleton and Subrahmanyan (1995).

order dominance shifts in background risk. Since they look at unrestricted second-order stochastic dominance shifts, the conditions on preferences that are required for these shifts in background risk to generate more risk averse behavior are also stronger.

So far we have assumed that background risk is independent of the insurable loss. This may not always be the case; for instance, poor health will normally be associated with a reduction in working ability and the efficiency of human capital.[11] Similarly, damages to equipment and machinery, caused for instance by a flood, may stop self-employed activity and worsen the distribution of the initial endowment. In both cases the insurable and the uninsurable risk are linked by a positive relationship. Eeckhoudt and Kimball (1992) show that in these circumstances background risk has a stronger positive impact on the demand for insurance both because of decreasing prudence and because of the positive dependence between the two risks.[12]

2.4 *Model specification*

Assuming that background risk, $\tilde{y}$, can be approximated by its certain component, y, and its variance, σ^2, the solution to the maximization problem (1) takes the form:

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[11] This will clearly be the case in the absence of protections against falls in earnings due to poor health. In Italy, the earnings of employees are essentially unaffected by temporary shocks to health because workers receive up to 12 months of full pay in case of illness.

[12] To define a positive relationship between the insurable loss and the uninsurable risk Eeckhoudt and Kimball (1992) assume that the distribution of background risk conditional upon a given level of the insurable loss deteriorates in the sense of third-order stochastic dominance.

$$(6) \qquad \Im_i^* = \Im(y_i, \sigma_i^2, L_i, \mu, p_i)$$

where i (i=1, ... N) indexes the households in the sample. Clearly, $\Im$* is an increasing function of the size of the loss L; it increases with p if the elasticity of the coinsurance rate a with respect to p is greater than 1; it falls with μ if the elasticity of a with respect to μ is smaller than 1.

The loss L is not directly observable but is strongly correlated with the level of individual resources, y. This implies that the effect of an increase in the certain component of resources on $\Im$* is, *a priori*, ambiguous: decreasing risk aversion implies that insurance falls with wealth, but an increase in wealth also raises the demand for insurance if the (unobservable) loss is positively correlated with the level of resources.[13]

Our previous discussion suggests that $\partial\Im^*/\partial\sigma_i^2 > 0$. We also argue that this derivative is likely to fall with wealth if prudence and risk aversion are sufficiently convex in wealth, thus $\frac{\partial}{\partial y}(\partial\Im^*/\partial\sigma^2)<0$. In the following section we seek empirical support for these two theoretical claims, i.e. that insurance demand is positively correlated with income risk and that this correlation falls with wealth.

3. Casualty insurance and income risk

Despite the growth of the theoretical literature, few empirical studies analyze the determinants of the demand for

[13] Mayers and Smith (1983) show that in a model of simultaneous portfolio and insurance choices, an increase in endowment wealth may increase the demand for insurance.

insurance and none, to our knowledge, the effect of other, uninsurable risks on the insurance decision. Clearly, this issue can be analyzed only in a sample that allows individual heterogeneity with respect to risk, i.e. with microeconomic data on households. For this purpose, we use a representative sample of Italian households which contains information on casualty insurance, households' resources and income uncertainty.[14]

There are at least two reasons for focusing on casualty insurance, rather than on health and life insurance, the other two most popular insurance contracts. Contributions paid to life insurance represent a mixture of a pure premium against the risk of premature death and of saving in a particular financial instrument; empirically, the premium is not distinguishable. In the Italian health insurance market there is substantial government intervention. In fact, to a very large extent health insurance is provided by the National Health Service, which imposes a flat contribution tax rate, offers universal coverage and insures most health risks for any amount. Since those who do not purchase health insurance can count on public health care, the demand for health insurance depends crucially on the quality of the public service (in addition to individual health risk). No such problems arise in the context of casualty insurance, where no public network exists and premiums truly reflect the price of risk avoidance. In fact we define casualty insurance as premiums paid to insure against the risk of property damages,

[14] The use of household-level data to study individual preferences can be problematic. One possibility is to assume that individuals within the household have identical preferences but differ in their wealth holdings, so that the behavior of one of the members at low wealth can be compared to that of another member at higher wealth. Alternatively, one can assume that individual preferences are represented by those of the household head.

fire and theft, and purposely exclude car insurance, which consists in part of compulsory liability coverage.

In our sample, about 10 percent of the households report spending on casualty insurance as defined above. Large spreads in the Italian insurance industry are likely to explain why relatively few households buy insurance (as shown in Section 2, if the load factor is sufficiently high, the optimal decision is to purchase no insurance). A rough estimate of the spread between actual and fair insurance is the ratio between premiums for casualty insurance paid to insurance companies and indemnities paid by insurance companies. This measure reflects both the presence of transaction costs and departures from perfect competition; in the Italian insurance market between 1988 and 1992 the ratio is as high as 1.25.[15]

Other evidence that the spreads between fair and actual premiums are large comes from international comparisons. In Italy the cost of insuring a property whose value is 90,000 ECU (including furnishings and belongings) against fire and theft was 370 ECU in 1991, the highest within the European Community (Gerardi, 1994).[16] The tax code also discourages insurance purchases: in some cases losses can be deducted from income (for instance, for small business or farmers), but premiums cannot.

The 1989 SHIW provides data on income, financial and real wealth and demographic variables for a representative sample of 8,274 Italian households. Balance-sheet items are

[15] Source: Ania (Association of Insurance Companies), *Annuario statistico*, Rome, 1993, Table 6.

[16] The EC average is 207 ECU, and the lowest value is 118 ECU in Belgium.

reported as of 31 December of the reference year; income and flow variables refer to the calendar year itself. The main features of the SHIW, its sample design, interviewing procedures and response rates are described by Brandolini and Cannari (1994).

A special section of the survey is designed to elicit information about the probability distribution of earnings and inflation prospects. The alternative to collecting subjective income expectations is to infer expectations from income realizations (typically in panel data). We do not find this alternative convincing, mainly because it assumes that the econometrician knows the agent's information set and how he uses it to form expectations. Subjective income information can be collected in various ways. For instance, Dominitz and Manski (1994) use the Survey of Consumer Expectations to construct a measure of subjective income uncertainty for 437 US households. Their questions refer to the cumulative distribution function of earnings, rather than the density function, as described below.[17]

In the 1989 SHIW each labor income or pension recipient is asked to attribute probability weights, summing to 100, to given intervals of inflation and nominal income increases one year ahead (the wording of the questions is reported in the Appendix). To construct a proxy for the subjective variance of real income, let $\tilde{z}$ denote the perceived growth rate of nominal labor and pension income, $\tilde{\pi}$ the perceived rate of inflation and $\tilde{x}$ the perceived rate of growth of real income, so that $\tilde{x} = \tilde{z} - \tilde{\pi}$. The variance of the random variable $\tilde{x}$ is then $\sigma_x^2 = \sigma_z^2 + \sigma_\pi^2 - 2\rho\sigma_z\sigma_\pi$, where ρ is the correlation coefficient

[17] Morgan and Henzion (1990) discuss the relative advantages of different procedures for eliciting subjective probability distributions.

between shocks to nominal income and inflation. Since next-period expected real income is $\tilde{y}_{t+1} = y_t(1+\tilde{x})$, its conditional variance is $\sigma^2 = \sigma_x^2 y_t^2$.

We observe the marginal distributions of perceived nominal income growht and inflation (which can be used to compute σ_z and σ_π) but not the correlation coefficient ρ. There are two ways to estimate the variance of real income growth. One way is to assume a certain value for ρ; in particular, we assume $\rho=-1$, the value of ρ that maximizes the expected variance. Alternatively, one can search over the range of admissible values for ρ and maximize the likelihood function by grid search. Empirically, the two strategies lead to very similar results, so only the former is reported in Section 4.[18]

Our proxy for uncertainty is subject to several critiques. Given the wording of the questions, the probability of a very low-income state, such as unemployment, may not be reported. The variance is a valid indicator of risk only under restrictive assumptions. In a general setting, the demand for insurance depends on lifetime income uncertainty, rather than on uncertainty one or several periods ahead. As mentioned, however, we find alternative measures of income risk even more questionable. Measures of uncertainty constructed from income realizations require very strong assumptions about the individual's information set. And proxies for income risk based on occupation may capture labor supply effects that have little to do with risk. Furthermore, in previous work we have found that the subjective variance is a useful indicator of income risk. Guiso, Jappelli and Terlizzese (1992, 1996) find

[18] The reason is that the likelihood function is rather flat over the entire range of the admissible values of ρ.

that subjective variance is positively related to asset accumulation and that households expecting more volatile incomes hold a smaller share of risky assets. Lusardi (1993), using the same proxy, also finds evidence in favor of a precautionary motive for asset accumulation.[19]

Due to missing data about inflation and income expectations, the sample is restricted to 4,078 households. Sample selection bias arises if non-responses are not randomly distributed in the population. The first column of Table 1 reports averages of the variables that will be used in the estimation for the entire SHIW sample (8,274 households). The latter includes a slightly lower proportion of young, married households with less education than our selected sample (see column 2). The estimate of households' resources (net wealth plus disposable income) is 10 percent higher in the selected sample. The proportion holding insurance and the amounts held are also larger in column 2. Overall, the relatively small differences between the total and the selected sample suggest that non-responses should not affect greatly the estimated coefficients.

Columns 3 and 4 of Table 1 report sample means for the group of households holding no insurance and for insurance holders. In the selected sample the fraction of households subscribing to casualty insurance is 13 percent; for this group annual premiums average 3 percent of disposable income. Insurance holders are younger, better educated, richer and more likely to live in the North and in larger cities than those who do not hold insurance. The fraction of the self-

[19] She also finds that workers who spent more time with the same employer tend to report lower income uncertainty, and interprets this as evidence of implicit insurance offered to workers by their employers.

employed is larger in the group buying insurance, (0.31 against 0.20).[20]

Households with insurance expect their incomes to be substantially more volatile than those without: the average income variance is 0.51 million lire in the group without insurance vis-à-vis a variance of 1.05 million lire for those buying casualty insurance. This is not a result of the variance being larger for richer households: the coefficient of variation of expected earnings is 1.4 percent in the sub-sample without insurance, against 2 percent among insurance holders. The descriptive evidence suggests that our proxy for income risk is strongly correlated with the insurance decision. However, a proper test of the proposition that background risk raises the demand for insurance requires that all variables affecting the latter are held constant and that account is taken of the sources of potential selection bias.

4. Empirical results

The model developed in Section 2 suggests that both the decision to insure and the amount of insurance depend on preferences, the probability of the loss, the terms of the insurance contract, the level and riskiness of household's endowment (see equation 6). We proxy unobservable preferences with a set of demographic characteristics (age, marital status and education of the household head, number of children under 18). The terms at which insurance is offered and the probability of a loss are also unobservable, but are likely to vary geographically; accordingly we introduce a set of regional dummies and city size indicators in the regressions.

[20] As will be seen in the next section, the effect of self-employment on the demand for insurance is difficult to interpret.

The level of the household's non-stochastic endowment is measured by total household resources defined as beginning-of-period net worth (real assets, financial assets and durable goods) plus disposable income.[21] We also introduce a dummy for self-employment (including professionals); *a priori*, the sign of this coefficient is ambiguous and will be discussed below.

Since the theoretical focus is on the effect of a mean-preserving spread in background risk on insurance demand, it is important that we control for the expected value of future uninsurable resources; accordingly, we introduce the expected value of earnings as a separate regressor.[22] As we argue in Section 2, the effect of income risk on the demand for insurance may vary with households' resources. To capture this effect we interact the subjective variance with current resources: the coefficient should be negative if absolute prudence and risk aversion are sufficiently convex.

We have no direct information on the size of the insurable loss and its riskiness. Yet the demand for insurance depends also on these variables. Furthermore, their omission might affect the interpretation of the effect of income risk: if the variance of income is simply proxying for omitted property risk (as would be the case if income and property risk were positively correlated), a positive effect of income variance on casualty insurance might reflect the fact that the demand for insurance depends on the variance of the insurable

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21 Beginning-of-period net worth is computed by subtracting 1989 savings from 1989 end-of-period net worth (see the Appendix for the definition of net worth).

22 We rely again on the subjective probability distribution of future income to construct this variable. We estimate expected future real earnings multiplying 1989 earnings by $(1+x-\pi)$, the expected real income growth, where x and π are the expected values of the random variables $\tilde{x}$ and $\tilde{\pi}$ respectively. This procedure is therefore fully consistent with the construction of the expected variance of earnings.

loss, rather than a genuine preference effect (reacting to uninsurable risks by raising coverage against risks that are insurable).[23]

Our measure of uncertainty would correctly reflect the effect of background risk on insurance only if earnings risk and property risk were independent. This may be a strong assumption. For instance, theft and fire may reduce the income of a self-employed person, suggesting a positive correlation between the insurable shocks to property and the uninsurable background risk. Our strategy for tackling this identification problem is twofold. First, we try to control explicitly for insurable risks to the individuals' property by proxying them with the value of home furnishings, appliances and valuables. When introduced into the regressions, however, the coefficients of these separate stocks of durable goods are not significantly different from zero, perhaps because they are already included as a component of household resources. Second, we focus on employees only: for this group the assumption of independence between income risk and property risk is certainly less questionable.

We have also experimented with a larger set of variables. The marginal tax rate may affect the demand for insurance negatively, given that tax deductions increase at high levels of income.[24] The variance is only a partial

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[23] The effect on the demand for insurance of a mean-preserving increase in the riskiness of the insurable loss is far from trivial. As mentioned in footnote 1, Meyer (1992) analyzes this problem when the initial endowment is random. He establishes sufficient conditions under which a constant-mean increase in the riskiness of the insurable loss leads to an increase in insurance. Under independence of the insurable and the uninsurable risks, the conditions include that utility exhibits decreasing absolute risk aversion, that relative risk aversion is non-decreasing and that it is does not exceed 1.

[24] The marginal tax rate is estimated for each single income recipient by a simulation model; we thank Dino Rizzi for providing us with the data.

representation of risk: households may react more strongly to negative income shocks than to positive ones. We thus construct a dummy indicating households with higher than average variance who expect large negative changes in real earnings (a drop of at least 5 percent). The coefficients of these variables, however, were not significantly different from zero, and are dropped from the final specification.[25]

First we analyze the insurance decision per se, then turn our attention to insurance amounts. In Table 2 we report the probit estimates of the demand for casualty insurance.[26] We also report the marginal effects of each variable. The probability of buying insurance depends positively on education and on number of children, and is lower for residents in the South and in small cities. The probability is a concave function of age, reaching a maximum at age 48. Household resources, expected future earnings and the expected variance of earnings increase the probability of purchasing insurance.

It is useful to evaluate the average predicted probability for varying levels of resources. For the 1,736

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[25] We also check the robustness of the results using a qualitative variable available in the 1989 SHIW. Each pension or labor income recipient was asked if he or she expected income to be volatile - "may go up or down considerably in the next five years", or stable "may go up or down somewhat or is expected to be stable in the next five years". For brevity these results are not reported. The dummy is positive and significantly different from zero in the probit estimates; in the amount equation the dummy is again positive but imprecisely estimated. The number of days ill in 1989, proxying for health hazards, was also added to the regressors, and dropped because not significantly different from zero.

[26] For comparison with the probit estimates, we also estimate a linear probability model. The latter is a consistent estimator but is less efficient than the probit if the errors are normally distributed; however, it is robust with respect to departures from normality. The results of the linear probability model are qualitatively similar to those of the probit, but the standard errors are larger. For brevity, these regressions are not reported.

households with resources between 100 and 200 million lire the average probability is 9.1 percent; for the 1,137 households with resources between 200 and 300 million it is 13.2 percent; for those with resources between 300 and 400 million (478 households) it is 18.0 percent.[27] The fact that the probability of purchasing insurance rises with household resources is not necessarily inconsistent with decreasing absolute risk aversion. As noted, if the endowment is correlated with potential losses, there could be a positive correlation between insurance purchases and wealth even under decreasing absolute risk aversion.

Income risk is an important factor in explaining the decision to purchase insurance. The coefficient of the expected variance of earnings is positive and significantly different from zero. The marginal effect is also positive, even taking into account the negative interaction term. In the group with relatively low variance (between 1 and 2 million lire), the average predicted probability is 13.2 percent; the probability increases to 19.4 percent for the group with expected variance between 2 and 5 million. Evaluated at sample means, the probability increases by 4.3 percentage points if the expected variance is increased from 1 to 10 million lire (the 95th percentile of the distribution of the expected variance).

The sign of the interaction term between the variance of income and the value of resources is negative. For relatively poor households (resources of 100 million lire), an increase in the variance of income from 1 to 10 million lire increases the probability of purchasing insurance by 5.7 points; for rich households (resources of 500 million) the

[27] Evaluated at sample means, raising resources from 100 to 500 million lire increases the probability by 8.8 percentage points.

same increase in the variance increases the probability by 0.8 points. As mentioned, the fact that the effect of income risk on the demand for insurance falls with wealth is consistent with convex prudence and risk aversion.

Switching to self-employment increases the probability of purchasing casualty insurance by 2.2 percentage points. Given the reduced form of the estimates, it is hard to interpret this effect. First, self-employment may proxy for income volatility. But as is noted by Skinner (1988), households in risky categories may have chosen self-employment because they are less risk-averse, in which case their propensity to insure may not be higher than that of the average household. Second, for the self-employed the potential loss from casualty risk may be larger than for employees, and their incentive to purchase insurance accordingly greater. Third, Gruber and Poterba (1994) point out that self-employed individuals typically have limited access to group insurance, so for them the load factor may be higher than for employees. For this reason they may end up spending more or less on insurance than employees, depending on the elasticity of the coinsurance rate with respect to the load factor.[28] Finally, and most importantly, for the self-employed the assumption that shocks to income are independent of the insurable loss is quite strong. A positive coefficient of self-employment may therefore reflect a positive correlation between income risk and the potential loss.

[28] Gruber and Poterba (1994) focus on health insurance. They find that insurance coverage rises with education and marriage; higher income families are much more likely to be covered with health insurance. They also report that the rate of private insurance coverage among self-employed persons is lower than among the employed: in the Current Population Survey, the rate of coverage is 85 and 73 percent, respectively. One explanation for this finding is that the self-employed have limited access to group insurance. Their reasoning applies to our case to the extent that group insurance is available also for casualty insurance.

The correlation between preferences and employment choice and the fact that the self-employed hold resources directly as well as through their business suggest that a sample including the self-employed can lead to inconsistent estimates. The second regression in Table 2 excludes 536 self-employed and professionals leaving only the employed workers in the sample. As argued, for this group the assumption that income risk and property risk are independent is more reasonable.

With respect to the full sample estimates, the effect of income risk on the insurance decision is larger: for instance, the average derivative reported in Table 2 is 0.48 for the employees *vis-à-vis* 0.22 in the full sample. If income risk and property risk are positively correlated for the self-employed but independent for the employees, then, *ceteris paribus,* the effect of income risk should be smaller for the employees. However, as mentioned, employees may be more risk-averse than the self-employed, implying a larger effect in the restricted sample. The estimates suggest that the latter effect dominates the former. We regard this as an interesting result; indirectly, it supports the claim that, given the correlation between occupation and risk aversion, self-employment is a poor proxy for income risk.

Next we use information on insurance amounts to see how they vary with household characteristics. Because of the censoring of the dependent variable, in Table 3 we report Tobit estimates of the demand for insurance. The sign pattern and statistical significance match those of the probit estimates. Other things being equal, increasing the expected income variance from 1 to 5 million lire (about two standard deviations above the mean) increases casualty insurance premiums by 0.057 million lire, about 80 percent of the sample mean. This represents the combined effect of income risk on the fraction of those choosing to purchase insurance and on the amount demanded by those already purchasing insurance. The effect of income risk excluding the self-employed is again larger than in the full sample estimates.

Tobit estimates are restrictive because the effects of the regressors on the insurance decision (the probits) and amount are constrained to be proportional. In Table 4 we present Heckman's two-stage estimator of the Tobit model, which is free of the proportionality hypothesis. The sign of the coefficients of the variance and of the interaction term are the same as in the Tobit estimates. However, the estimates have poor standard errors.[29] This last set of results suggests that the effect of income risk on the insurance decision is substantial; the effect on amounts is positive, as predicted by the theory, but poorly estimated, possibly reflecting small sample size.

Overall the results suggest that background uncertainty has a sizable effect on the decision to purchase casualty insurance. Since one form of insurance consists simply in engaging in less risky activities, people who would be likely to buy more insurance - i.e. more risk-averse individuals - would also tend to avoid income risk to begin with. If this self-selection problem is empirically relevant, the true impact of background risk on insurance demand is larger than what we find and our estimates provide only a lower bound for the true effect.

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[29] The second-stage results do not change if we introduce other variables - such as dummies for income recipients, region or education - in the first-stage probit estimates.

5. Conclusions

Individuals face multiple sources of uncertainty: some can be partially dealt with in insurance markets, others must be fully borne. As shown by Kimball (1993), even when these two types of risks are statistically independent they are likely to aggravate one another. Prudent individuals will then take actions aimed at reducing their exposure to avoidable risks in response to increases in unavoidable risks. In this paper we use the 1989 Italian Survey of Households Income and Wealth to test some of the implications of the theory of insurance under multiple sources of risk.

We relate the demand for casualty insurance to a self-reported measure of income risk. The findings suggest that insurance demand is positively affected by uninsurable income risk. The results are especially strong for insurance decisions, weaker for insurance amounts. In the group with relatively low expected income variance the average predicted probability of purchasing insurance is 13.2 percent; the probability increases to 19.4 percent for the group with relatively high expected variance. It is also found that the effect of income risk on the insurance decision falls as the level of households resources rises.

The results are consistent with the argument that an increase in unavoidable uncertainty induces risk-averse households to increase coverage against the risks that can be avoided. The sensitivity of insurance demand to changes in background uncertainty places restrictions on decision makers' preferences which involve higher order derivatives of the utility function. In particular, the findings support decreasing (and possibly convex) absolute prudence and risk aversion.

Our results might have implications for the cyclical behavior of insurance premiums (Gron and Lucas, 1995): if income uncertainty varies over the business cycle this alone can induce insurance cycles. Furthermore, policies that change the amount of background risk - such as unemployment compensation or wage indexation - may impact on the demand for insurance; this suggests that the wide international differences in the development of insurance markets might be partly due to differences in the amount of background uncertainty faced by each country's citizens.

APPENDIX

Definitions of variables

Household size. Total number of persons in the family. Persons include head, spouse (whether formally married or not), children, other relatives and non-relatives living in the household. The variable "number of children" includes dependent children only.

Education. The survey responses are coded as: 0 (no education), 5 (completed elementary school), 8 (completed junior high school), 13 (completed high school), 18 (completed university degree), 20 (postgraduate education).

Occupation. Coded as: (1) operative or labourer; (2) clerical; (3) professional, manager or entrepreneur; (4) self-employed.

Sector of occupation. Coded as: (1) agriculture, (2) industry, (3) services, (4) public administration.

Disposable income. Sum of wages and salaries, self-employment income and income from financial and real assets, less income taxes and social security contributions. Wages and salaries include overtime bonuses, fringe benefits and payments in kind, and exclude withholding taxes. Self-employment income is net of taxes and includes income from unincorporated business, net of depreciation of physical assets.

Net worth. Sum of household's net financial assets and real assets. Real assets are the sum of real estate, unincorporate business holdings and durable goods (appliances, home furnishing and valuables). Net financial assets are imputed from the flow of financial income (interest on checking accounts, savings accounts, money market accounts, certificates of deposit, stocks, Government bonds and other bonds plus dividends, less interest on household liabilities). We estimate an average after-tax interest rate by weighting the after-tax interest on deposits, government bonds, currency and other financial assets by their shares in the financial accounts data. The estimated average after-tax interest rate is 8.29.

The measure of uncertainty

In the 1989 SHIW the following two questions were asked to each labor income or pension recipient.

Inflation uncertainty. On this table we have indicated some classes of inflation. We are interested in knowing your opinion about inflation twelve months from now. Suppose that you have 100 points to be distributed Between these intervals (a table is shown to the person interviewed). Are there intervals which you definitely exclude? Assign zero points to these intervals. How many points do you assign to each of the remaining intervals?

For this and the following question the intervals of the table shown to the person interviewed are the same. The intervals are: >25 percent; 15-20: 13-15; 10-13; 8-10; 7-8; 6-7; 5-6; 3-5; 0-3, less than 0. In case it is less than zero, the person is asked: How much less than zero? How many points would you assign to this class?

Earnings uncertainty. We are also interested in knowing your opinion about (your) labor earnings or pensions twelve months from now. Suppose that you have 100 points to be distributed between these intervals (a table is shown to the person interviewed). Are there intervals which you definitely exclude? Assign zero points to these intervals. How many points do you assign to each of the remaining intervals?

Table 1

INSURANCE PREMIUMS BY ECONOMIC STATUS AND DEMOGRAPHIC CHARACTERISTICS OF THE HOUSEHOLD
(1989 SHIW)

Variable	Total sample	Selected sample	No insurance	Casualty insurance
	(1)	(2)	(3)	(4)
Age	51.34	49.23	49.38	48.25
Married	0.70	0.80	0.79	0.83
Number of children under 18	0.69	0.69	0.70	0.68
Education	8.47	9.53	9.32	10.93
Self-employed	0.22	0.21	0.20	0.31
Households resources	169.94	186.31	164.42	330.95
Expected earnings	--	30.41	28.66	41.97
Resident in the North	0.41	0.47	0.43	0.77
Resident in the Center	0.22	0.16	0.17	0.13
Resident in the South	0.37	0.36	0.40	0.10
City < 25,000	0.11	0.14	0.14	0.12
25,000 < City > 250,000	0.51	0.52	0.53	0.48
250,000 < City <1,000,000	0.17	0.15	0.15	0.17
City > 1,000,000	0.21	0.19	0.18	0.22
Subjective income variance	--	0.58	0.51	1.05
Casualty insurance > 0	0.10	0.13	0.00	1.00
Amount of Casualty insurance	0.05	0.07	0.00	0.54
Observations	8,274	4,078	3,542	536

Note. Resources, earnings, casualty insurance and the subjective income variance are expressed in million of 1989 lire.

Table 2

THE EFFECT OF INCOME RISK ON THE INSURANCE DECISION: PROBIT ESTIMATES

	Total sample			Excluding self-employed		
	Coefficient	*t*-stat	Marginal probabilities (x100)	Coefficient	*t*-stat	Marginal probabilities (x100)
Age	0.069	4.28	-0.01	0.062	3.35	-0.01
Age^2	-0.720E-3	-4.45	--	-0.645E-3	-3.50	--
Married	-0.046	-0.59	-0.82	-0.151	-1.67	-2.65
Number of children	0.038	1.05	0.50	0.056	1.31	0.65
Education	0.024	3.45	0.30	0.018	2.21	0.21
Self-employed	0.138	2.03	2.26	--	--	--
Household resources	0.001	8.64	0.01	0.001	7.68	0.02
Expected earnings	0.007	4.44	0.09	0.009	4.13	0.10
Resident in the North	0.495	6.38	6.78	0.537	5.84	6.56
Resident in the South	-0.538	-5.54	-11.78	-0.513	-4.37	-10.53
25,000 < City > 250,000	0.266	2.25	4.10	0.274	2.68	5.86
250,000 < City <1,000,000	0.477	3.05	6.59	0.381	3.04	5.07
City > 1,000,000	0.462	4.54	6.44	0.459	3.88	3.86
Income variance	0.035	2.25	0.22	0.062	2.78	0.48
Income variance * resources	-0.064E-3	-2.46	--	-0.092E-3	-2.13	--
Constant	-3.873	-9.53		-3.74	-7.99	
Observations		4,078			3,202	
R^2		0.181			0.172	

Note. Marginal probabilities are computed as follows. For continuous variables we evaluate the partial derivative of the probit function, $\phi(X_{ik}\beta_k)(\partial X_{ik}\beta_k/\partial X_{ik})$, where i=1, ...N denotes the households in the sample, β_k the estimated coefficient and ϕ the density function of the normal distribution. We then take the sample average of this derivative. For indicator variables, we predict the probability of purchasing insurance if the dummy is equal to one and if the dummy is equal to zero, and take the average difference of these predictions across households.

Table 3

THE EFFECT OF INCOME RISK ON INSURANCE AMOUNTS: TOBIT ESTIMATES

	Total sample		Excluding self-employed	
	Coefficient	*t*-stat	Coefficient	*t*-stat
Age	0.068	4.22	0.042	3.02
Age^2	-0.721E-3	-4.45	-0.45E-3	-3.25
Married	-0.061	-0.80	-0.156	-2.32
Number of children	0.016	0.44	0.027	0.84
Education	0.015	2.21	0.010	1.68
Self-employed	0.237	3.67	--	--
Household resources	0.001	10.20	0.001	8.42
Expected earnings	0.009	5.49	0.008	4.90
Resident in the North	0.439	5.65	0.362	5.15
Resident in the South	-0.500	-5.14	-0.351	-3.95
25,000 < City > 250,000	0.343	3.95	0.250	3.25
250,000 < City <1,000,000	0.465	4.43	0.277	2.92
City > 1,000,000	0.400	3.94	0.288	3.19
Income variance	0.030	1.90	0.045	2.26
Income variance * resources	-0.074E-3	-2.71	-0.084E-3	-1.86
Constant	-3.872	-9.19	-2.705	-7.39
Observations		4,078		3,202
R^2		0.169		0.162

Table 4

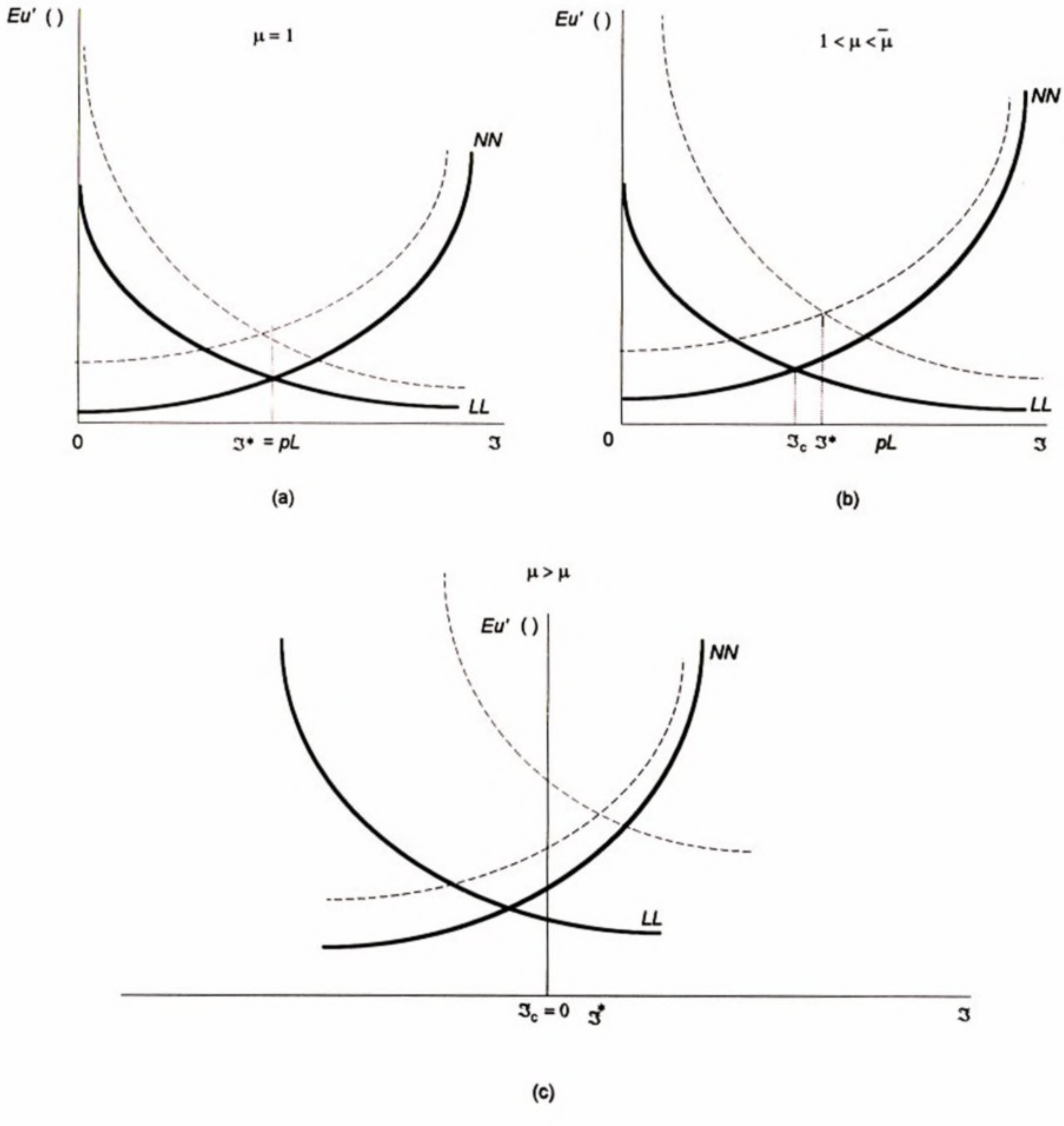
THE EFFECT OF INCOME RISK ON INSURANCE AMOUNTS: GENERALIZED TOBIT ESTIMATES

	Total sample		Excluding self-employed	
	Coefficient	*t*-stat	Coefficient	*t*-stat
Age	0.046	1.39	0.012	0.33
Age^2	-0.500E-3	-1.46	-0.174E-3	-0.44
Married	-0.059	-0.70	-0.179	-1.69
Number of children	-0.017	-0.42	-0.001	-0.21
Education	-0.003	-0.31	0.001	0.03
Self-employed	0.369	4.24	--	--
Household resources	0.001	2.64	0.001	1.24
Expected earnings	0.008	3.07	0.007	1.61
Resident in the North	0.248	1.23	0.176	0.58
Resident in the South	-0.229	-0.91	-0.056	-0.17
25,000 < City > 250,000	0.407	2.93	0.286	1.76
250,000 < City <1,000,000	0.302	1.43	0.202	0.93
City > 1,000,000	0.206	1.00	0.145	0.57
Income variance	0.019	0.81	0.040	1.11
Income variance * resources	-0.070E-3	-1.85	-0.116E-3	-1.96
Constant	-2.477	-1.29	-1.152	-0.44
Observations		536		370
R^2		0.242		0.165

Note. Standard errors are corrected for two-stage estimation.

Figure 1

THE EFFECT OF BACKGROUND RISK ON THE DEMAND FOR INSURANCE



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