A NOTE ON INSURANCE MARKET STRUCTURE WITH ASYMMETRIC INFORMATION

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Abstract

It is well known since Rothschild–Stiglitz (1976) that competitive equilibrium may fail to exist in insurance markets. On the other hand, even in non-competitive markets, such as a monopoly, Stiglitz (1977) had shown that insurance markets suffer from another drawback – that under certain conditions, only higher risk consumers are sold insurance. In this paper we explore whether there are economies for which both the above pathologies can co-exist. That is, we ask, whether there are economies with insurance markets, such that if there is competition, then there is no equilibrium, and if there is a monopoly, then the low risk consumer is shut out. The answer is negative, for the class of economies that we consider in this paper.

Introduction

Rothschild– Stiglitz (1976) (henceforth RS76) pointed out the problem of non-existence of competitive equilibrium in insurance markets with asymmetric information. The key insight in their paper was that equilibrium unravels, since competing insurance sellers try to lure away profitable customers (i.e., the low risk types), without actually being able to identify such customers, exante. On the other hand, Stiglitz (1977), analysing the polar non-competitive case of a profit maximising monopolist, showed that the monopolist might find it optimal not to offer any contracts to the low risk type, in two risk types case. Thus both market structures, competition and monopoly, in insurance markets seem to throw up unsatisfactory features – either competitive equilibrium fails to sustain, or one segment of the market does not get served. This observation in turn has provided fuel to the proponents arguing for a 'publicly owned' monopoly in insurance – i.e., a monopoly without a profit maximising motive.

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While we do not go into this debate here[1], we wish to explore whether in the simplest scenario of two risk types who are otherwise identical, an insurance economy can simultaneously exhibit the two pathologies, i.e., an absence of competitive equilibrium (*a la* RS76), and an absence of total coverage of the market by a monopolist (*a la* Stiglitz (1977)). Since the analytical expressions are somewhat intractable, we use numerical simulations. Our results indicate that these two phenomena cannot occur together. Thus for the range of parameters considered here, either a competitive equilibrium must exist, or if not, then a profit maximising monopolist will find it profitable to sell to both risk types.

The Problem

For the purpose of this paper an insurance economy is a six-tuple (W, D, p, q, λ, u) where W (initial monetary wealth) and D (possible damage or loss amount) are non-negative numbers, p, q are probabilities (of the high and low risk) types, with $p>q$, λ is the proportion of high risk type in the total population, and u is the strictly increasing, strictly concave, twice differentiable, common utility function of money, for both the risk types.

Roughly following the approach of RS76, we assume that agents are expected utility maximisers. There are two states of nature (say 'good' and 'bad'). Insurers sell insurance contracts, and seek to maximise profits by setting appropriate premiums. An insurance contract is denoted by a pair (α, β), which are respectively the net amounts paid by the insurer to the customers in the two states. Typically $\alpha < 0$ is called the premium, and $\beta > 0$ is called the coverage (net of premium). Insurers cannot a priori distinguish between the two risk types. Each insurer firm sells only one contract (although there may be wide variety of contracts sold in the market.)

If a competitive equilibrium does exist, as analysed in RS76, it must be that two separate contracts are offered in equilibrium, such that on each contract firms make zero expected profits, and these two contracts are incentive compatible, i.e. the high risk types do not find it profitable to masquerade as low risk types and purchase the other contract, meant for the low risk customer.

On the other hand a profit maximising monopolist would sell only one type of insurance contract, i.e. only to the high risk type customer if λ, the proportion of high risk type, satisfies[2]

The value of β_h corresponds to "full coverage" to the high risk type customer,

$$\frac{\lambda}{1-\lambda} > \left(\frac{u'(W-D)}{u'(W)} - 1\right)\frac{q(1-q)u'(W-D+\beta_h)}{(p-q)u'(W-D)} \tag{1}$$

[1] In a recent exposition Rothschild-Stiglitz (1997) have reiterated the incompatibility of competition and insurance, and suggest that, if unregulated, competition can destroy insurance markets.

[2] For a derivation of this condition, see Stiglitz (1977).

which leaves him at his reservation utility. Thus

$$u(W-D+\beta_h) = (1-p)u(W) + pu(W-D) \qquad (2)$$

In a competitive market, in equilibrium, the high risk type gets 'full coverage', i.e. purchase of insurance results in equal wealth across the two states[3], and the low risk type gets partial coverage, determined by the incentive compatibility constraint. This insurance contract offered to the low risk type $(\alpha_\ell, \beta_\ell)$ is such that if the high risk type purchased it, it would give him the same utility level as getting full coverage. This is expressed in the equation below.

$$u(W-pD) = (1-p)u(W-\alpha_\ell) + pu(W-D+\beta_\ell) \qquad (3)$$

The zero profit condition implies that $\alpha_\ell = \dfrac{q\beta_\ell}{1-q}$. The indifference curve of the low risk type at this contract gives a utility level (say $\overline{V}$) whose expression is:

$$\overline{V} = (1-q)u(W - \frac{q\beta_\ell}{1-q}) + qu(W-D+\beta_\ell) = (1-q)u(x) + qu(y) \qquad (4)$$

The curve in (4) is written in terms of (x, y), where x and y denote net wealth in the 'good' and 'bad' state respectively.

Competitive equilibrium fails to exist, if the a indifference curve of (4) intersects the pooled probability $\overline{p} = \lambda p + (1-\lambda)q$ below the 45-degree line in the $x-y$ plane. The equation of pooled line is given by

Thus for the simultaneous absence of competitive equilibrium and absence of coverage to

$$(y-(W-D)) = -\frac{(1-\overline{p})}{\overline{p}}(x-W) \qquad (5)$$

low risk type by a monopolist, we look for parameters (W, D, p, q, u, λ) which satisfy inequality (1), and which give rise to an intersection of curves (4) and (5) below the 45 degree line (i.e. $x<y$). This is illustrated in Figure 1, wherein the point T represents the full insurance point of the high risk type, and the lines EH and EL are the zero profit (actuarily fair) price line for high and low risk types respectively. The pooled line in the figure lies below the $\overline{V}$ indifference curve (represented as U_L in the figure), implying the existence of competitive equilibrium.

[3] This equal wealth across two states is $\dot{W} - \alpha$ in our notation, which is equivalent to the condition $\alpha + \beta = D$.. Also note that the zero profit condition for each contract implies that $(1-p)\alpha + p\beta = 0$ and so also for q^ instead of p.

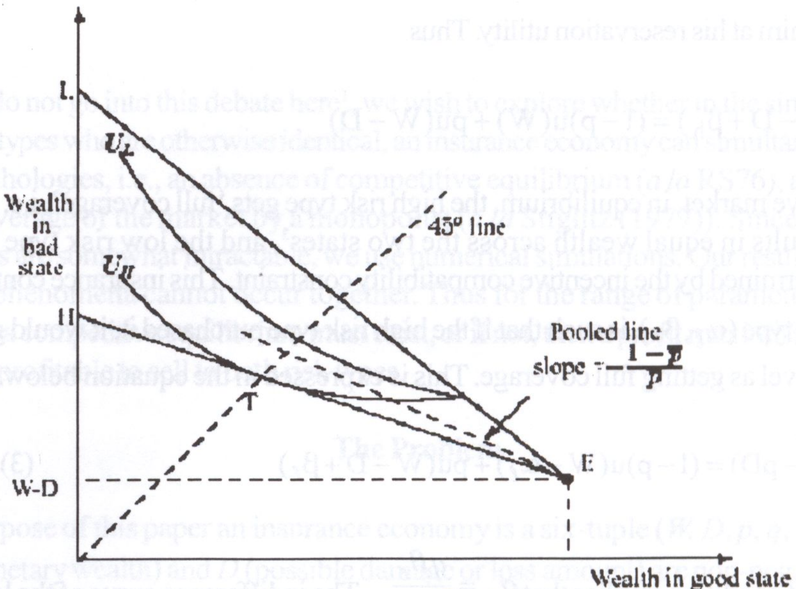

Figure 1

The search for a set of parameters and wealth levels (x, y) which satisfy (1) and lie on equations (4) and (5) involves solving implicit functions, and this is analytically somewhat intractable. Hence we resort to numerical simulations, whose results are presented below. Let the explicit relationship between x and y for the indifference curve given by (4) be written as $y = f(x)$ and for the pooled line give by (5) be written as $y = g(x)$ In the simulations presented graphically below, we look for points x where $f(x)-g(x) = 0$, for $x < y$ g implying an intersection below the 45 degree line.

Simulation Results

We work with the following three utility functions: (a) $u(x) = 1 - \exp^{-px}$ (b) $u(x) = \log x$ and (c) $u(x) = \sqrt{x}$. The results of the simulations are presented in Figures 2 to 7. We start with a which satisfies (1) and then seek to find some parameters (W, D, p, q) for the given utility function, which can give us non-existence. As can be seen even for extreme values of p, q (which are very close to each other, thus enhancing the likelihood of non-existence of competitive equilibrium), we do not obtain values of x for which $f(x) - g(x)$ is 0 or negative.

Concluding Remarks

From our simulation results it appears that in the two risk type case for CARA, log and square root utility functions it is not possible that an economy can simultaneously exhibit non-existence of competitive equilibrium and non-total coverage by a profit maximising monopolist. Of course proving this proposition analytically is desirable, and future research will perhaps provide the appropriate proofs. It must be pointed however, that for more than two risk types the question is open. Also in case of a continuum of risk types, both the phenomena can occur simultaneously.

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Figure 2:

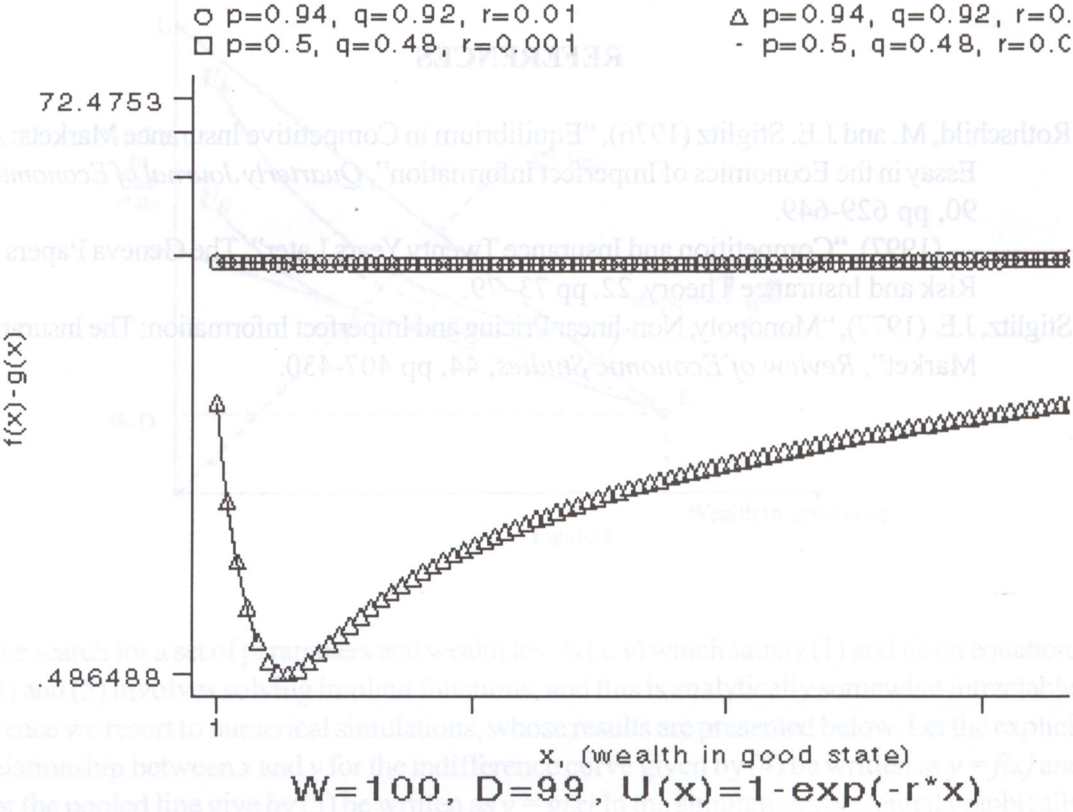


Figure 3:

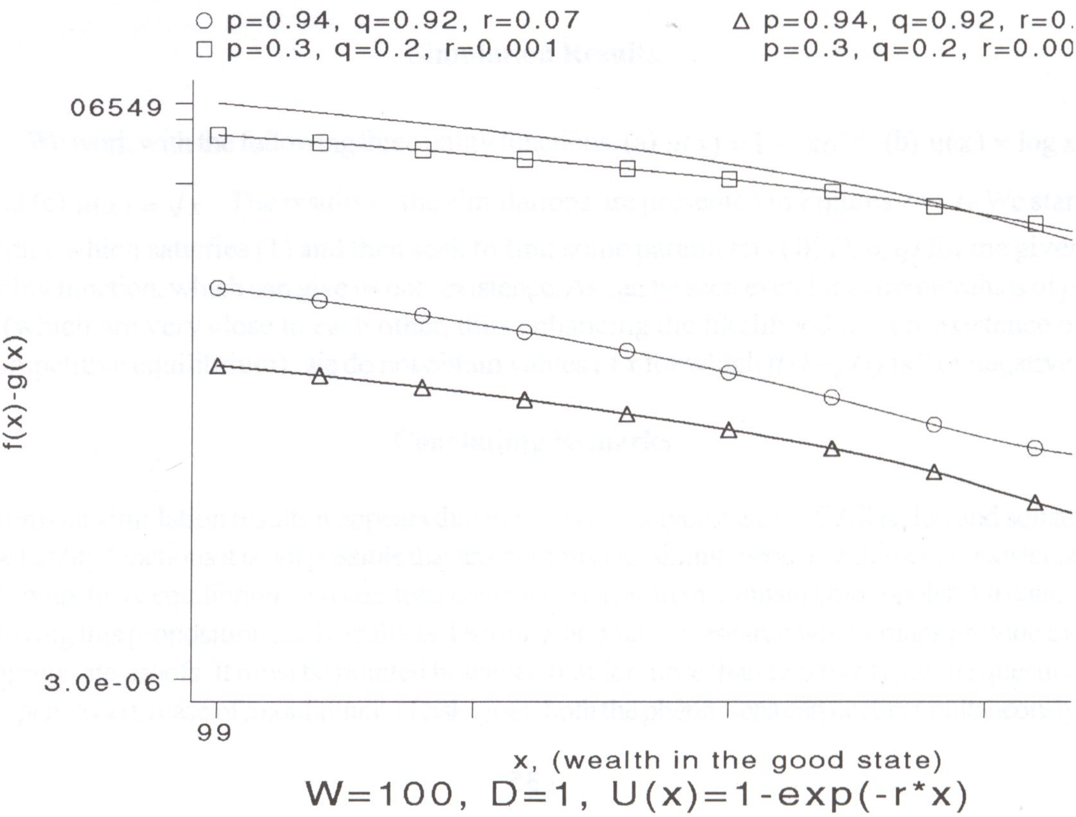
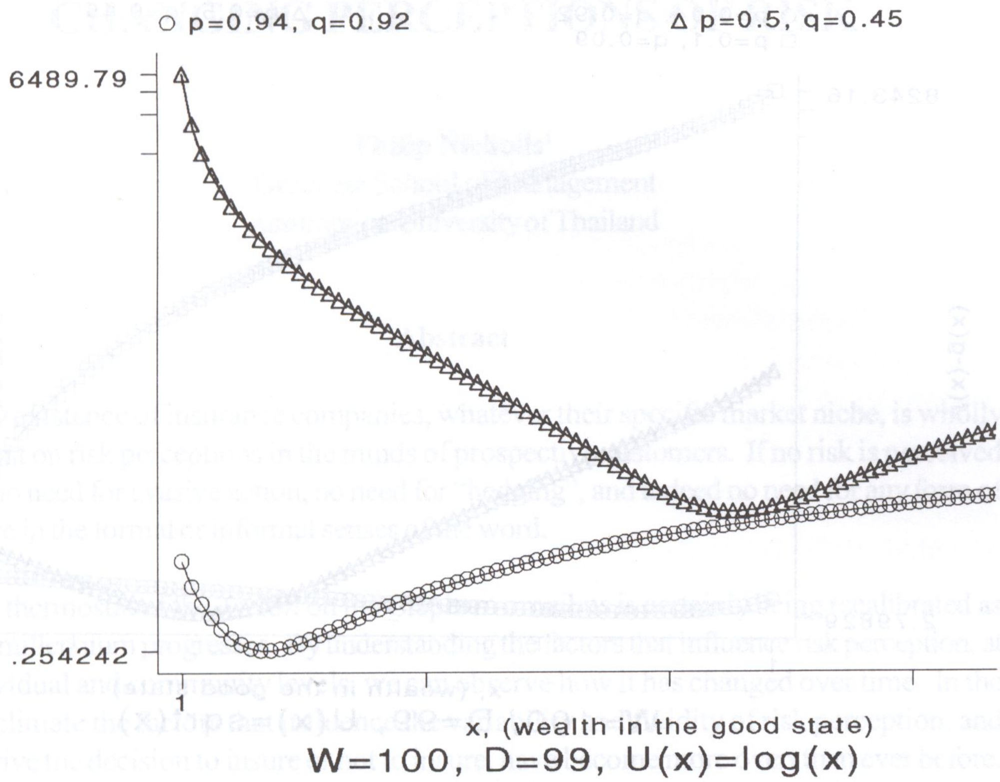


Figure 4:



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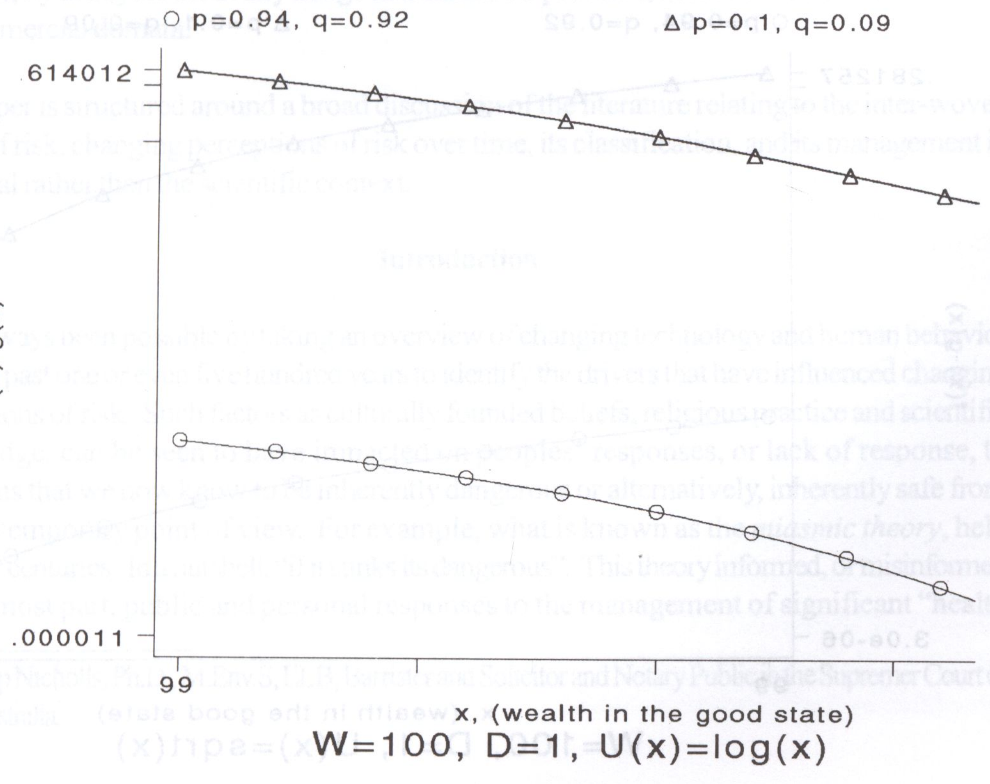

Figure 6:

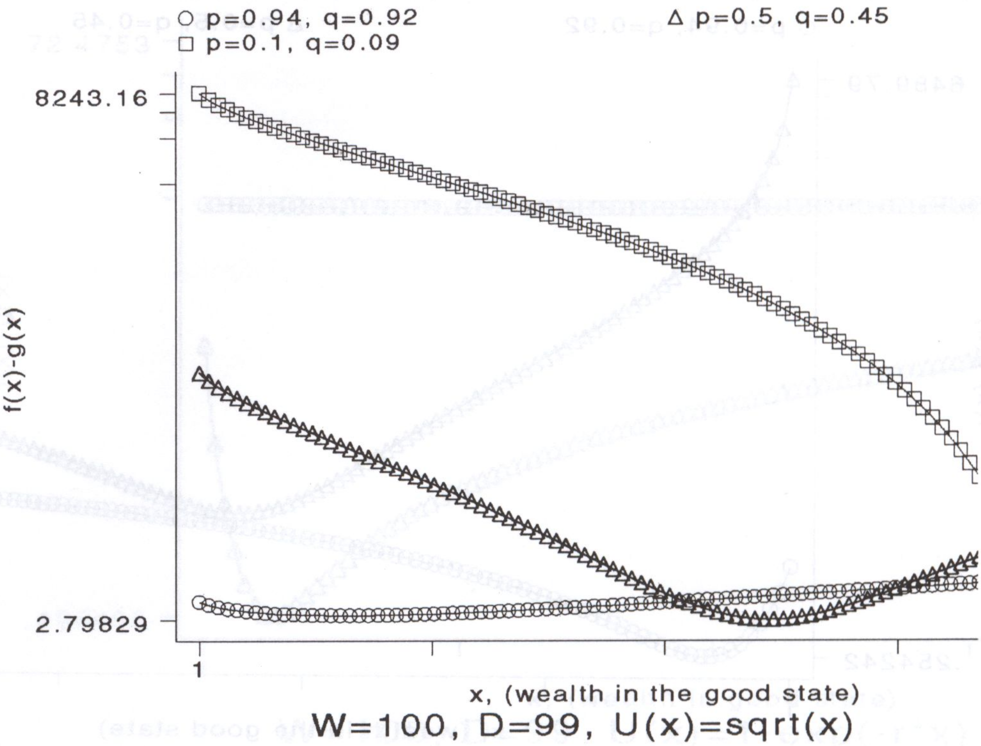

Figure 7: