Heterogeneity, Systemic Risk and the Insurance Role of the State

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Abstract

We provide a rationale for public universal insurance coverage based on (1) individual heterogeneity and (2) the presence of systemic risk. Contrary to most accounts of market failure in insurance markets, e.g. in the case of health insurance, we do not rely on asymmetric information. The argument goes as follows: on the one hand, systemic risk (possibly related to the inability to specify in advance all relevant contingencies) prevents the supply of long term insurance contracts by private insurers, as such contract would result either in excessive risk for the insurer or in poorly designed contracts that leave individuals exposed to unforeseen contingencies. On the other hand, heterogeneity invites insurers to segment the market and provide less than optimal risk coverage; the reason is that short term insurance contracts will take into account heterogeneity, so that individuals will not be insured against the risk of being classified as high risk. We argue that the alternative represented by pooling all risks through a universal long term (life-long) public insurance may result in an efficiency gain, even when this implies a departure from optimal individual insurance. Moreover, as it can rely on some kind of collective decision making mechanism, the public solution allows to adjust the "contract" to long term changes affecting the cost of providing insurance.

Keywords: Risk heterogeneity, systemic risk, public provision of insurance

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1. Introduction

The main programme of public expenditures in most advanced economies are pensions and health. In this regard, we might say that the State plays a major role in providing insurance to citizens.

The usual explanation of why in some cases mandatory universal insurance is welfare improving is based on market failues due to information asymmetries, namely adverse selection (Barr, 2001).

As it is well known, adverse seletion explains why in a competitive insurance market where, because of the inability to tailor price to individual risks, pooling contract are offered, some individuals with low risk will rationally choose not to buy insurance. However, this explanation seems at odds with the simple observation that the main issue in health insurance market seems to involve high risk individuals, not low risks. An example in this regard is Medicare, the main government program introduced by the US administration, which provides coverage to "high risk" old (over 65) individuals.[1] Moreover, one may wonder whether, in an era where information and data might be easily accessible and collectible, a representation in terms of an information advantage by the patient, as assumed by model based on adverse selection, is correct.

Adverse selection does not seem to provide a fully convincing representation of the main failures we observe in health insurance market, which justify a major departure from market based provision of health in most advanced economies.

Another failure which has been at the centre of recent reforms (e.g. Obama's Affordable Care Act), and on which many contributions have focused in the last decade, is the fact that competitive markets are not able to insure against the risk that, over the long run, individuals who suffer particularly severe health problem may see their insurance premia increase to the point that they are not able to afford insurance. So called *reclassification risk* can be easily illustrated as follows: suppose an individual is diagnosed a serious illness with an expected cost of 20,000 euro per year for the rest of his/her life. If the insurance contract can be renegotiated, i.e. if the premium has not been fixed in advance for the whole life of the individual, such increase in expected expenditure will be reflected in an increase in future annual premium. Risk-averse consumers value not only coverage for fluctuations around their expected annual health spending, they also value coverage for health state transitions, such a serious illness that may permanently affect their expected health care consumption and thus their health insurance premium.Indeed, some empirical studies confirm that the main problem, also in terms of welfare loss, met by individuals in competitive insurance market is one of reclassification of risks rather than one of adverse

[1] A more sophisticated model explains why the progressive exit of low risk individuals due to adverse selection pushes the insurance premiums up, entering a "death spiral", until the high risk may find it too costly (Cutler e Zeckhauser, 1998).

selection (Handel *et al.*, 2015).

Not that an increase in expenditure might simply reflect the fact that health risk increases with age. In this regard, incomplete health insurance may be an instance of the problem we also find in the provision of pension; because of myopia or some kind of time inconsistency, individuals may fail to consider their future needs. However, something more seems to be at play in the case of health. Health expenditure is highly heterogeneous among individuals; this implies that, even at the same age, the cost of insurance may be much different. Indeed, the insurance dimension is certainly much more relevant for health than it is for pensions.

In this paper we use the case of health insurance to propose a different account of why public intervention, in the form of regulation of private market or direct provision of insurance, may solve a market failure due to the the heterogeneity of individual risks. Note that heterogeneity is also at the basis of the adverse selection explanation. However, what we think is interesting is that the failure to provide efficient insurance coverage through a competitive market is not the effect of some form of asymmetric information. Rather, at the basis is the opposite idea that in a long term contract the parties can take advantage of new *common* information about the characteristics of the parties. If they were able to do, individuals would be better off by committing not to use information available; the fact that this is not possible has the effect of making insurance impossible or inefficient.

A crucial ingredient of our explanation is that the parties cannot commit contractually to an efficient solution, as this would require a long-term contract and such contract is not feasible. Hence, a satisfactory explanation should include a justification for the fact that long term contracts are not offered or demanded in a competitive market.

Admittedly, there might be a number of reasons why a market does not provide long term contracts even when this would be efficient (Poterba, 1994). In many relevant cases, among which the case of health care, we think that such market failure is a consequence of the systemic nature of the risk involved. Here is the second crucial ingredient of our explanation: over the long run, the characteristics of the risk are going to change in a way which has some common features for all individuals involved, but it cannot be specified in a private contract.

In short, we propose an explanation for mandated universal provision of insurance based on the combination of two effects: (1) information on individual levels of risk is revealed as time passes and (2) risks have a systemic, hence uninsurable, component. A different way to present our argument is that the efficient solution involves a long term contract whose terms the parties commit not to revise when new information is available, but such a long term contract is unfeasible due to systemic risk.

As a consequence, the second best solution involves government intervention, either in the form of a mandate to subscribe a uniform long term contract or as ex post compensation of risks. As we will see, the characteristics of the resulting equilibrium are consistent

with what we observe in markets such as the US health insurance market, and provide a rationale for publicly mandated universal insurance.

2. Review of the literature

The logic behind our argument has been considered in the literature under the label of reclassification risk. Moreover, it is reflected in recent reforms of the health insurance in countries where provision of insurance is private and market based. In the US, Restrictions are present since the 1970s that prohibit plans from setting different premiums based on health status try to cover the risk of becoming reclassified as an expensive patient in some future period.

The relevance of such risk has been first analysed by Cochrane (1995) (see also Diamond, 1992). documented in a number of studies, showing variation in premiums across employers in the small group market (Cutler, 1994; Cebul *et al.*, 2011).[2] Using an employer survey, Cutler found that the 90th percentile of premiums is 2.74 times the 10th percentile for this market. Many researchers has interpreted this findings as suggesting that the premium variation in is mostly due to reclassification risk from experience rating, i.e., from individuals with higher expected health risks facing higher premiums.

Empirically, this reclassification risk seems important. More than half of US households contain a member with a pre-existing condition (Kaiser Family Foun- dation 2016). Calibrations by Handel, Hendel, and Whinston (2015) suggest that the welfare benefits of eliminating reclassification risk may swamp the welfare costs of one-period adverse selection. While we feel obligated to bring attention to this understudied and important issue, we will focus here primarily on the interaction between policies like community rating that address this reclassification risk, and selection. There is a subtle but important additional efficiency cost of premium rating restrictions. If consumers have heterogeneous preferences over insurance plans, a point on the marginal cost curve represents the average cost over a set of heterogeneous consumers who place the same value on insurance, and no uniform price can efficiently sort all consumers (Glazer and McGuire 2011; Bundorf, Levin, and Mahoney 2012; Geruso forthcoming).

However, we think such contributions suffer a limitation. On the one hand, conditioned by data availability, they tend to focus on changes of risk classification over short periods of time; on the other hand (and related to the previous point), they do not take into account af an important characteristic of the expenditure determining the amount of payment to insured individuals: namely, the fact that health expenditure tends to increase much more rapidly than overall expenditure because of technological innovation. Technological innovation, by making available new treatment and modifying the cost of existing ones, affects the level of expenditure of all individuals, introducing a source of systemic risk

[2] For a dissenting point of view on the actual relevance of such risks, see however Fleitas *et al.* (2018).

into the picture; second, technological change makes difficult to specify in advance the details of the contract, for example which treatments are covered by the insurance, under which conditions and so on.

3. A numeric example

Consider individuals can be either weak or strong. If he is weak, the probability to be sick is 0.4, while if he's strong such probability is only 0.15. If the individual is sick he suffers a loss of 1,000. Assume it is known that the percentage of weak individuals is 0.2.

A "pooling" contract, which insurers a mix of individuals picked up at random, will refund the cost 1,000 with probability $0.2 \times 0.4 + (1 - 0.2) \times 0.15 = 0.2$. Hence the actuarially fair premium for such contract will be 200. Note however that with such a contract strong individuals cross subsidize weak individuals, because they pay a premium higher than their risk. Risk aversion could still be high enough that they prefer to be insured at a premium 200 (higher than the expected loss) than staying uninsured.

However, in case the insurer can observe the type of the individual and such a pooling contract is offered, there will be an incentive for a different insurer to "cream skim" individuals by offering a contract with premium less than 200 only to strong individuals.

If strong individuals are attracted by the new lower premium contract, the "pooling" contract will not be sustainable for the first insurer. Hence, the only possible equilibrium is a "separating" one where each individual pays a premium corresponding to his type (level of risk).

This is an instance of the general conclusion that in a competitive market there cannot be cross subsidiation.

In such a context, imposing a "pooling" contract, for example by mandating or providing universal insurance, cannot be justified on the ground of efficiency. The fact that high risks pay more than low risks simply reflect their respective characteristics. Each individual receives full insurance at his actuarially fair premium, and this amounts to efficient insurance.

Consider however a slightly different framework. Assume that individuals can be either weak or strong, but their type is known neither to themselves nor to insurers when the contract is signed. Assume further that the time horizon is of two periods, and that the probability of being sick in the second period is correlated to the probability the individual has been sick in the first period.

This can depend either on the fact that the disease can be chronic, or on the fact the individuals' types are revealed by the fact they have been sick.

In this two period framework, in case the insurance contract is signed at the start of the second period, there will be an incentive for the parties to take into account the available information about the health status of the individual. Note that such incentive will be for

the insurer, who has a clear interest in identifying and selecting the "best" risks, but also for the individuals who have not been sick in the first period, whose interest is to reveal his health condition in order to take advantage of a lower premium.

We will return on the possibility to prevent the use of available information, but it is fair to assume that this will not be possible, and in the second period a separating equilibrium will take place.

Things could be different if individual could sign a long term insurance contract at the beginning of the first period, for the two periods. Such contract would be ex ante efficient, as the individual does not know at the start his own "type", and is willing to insure against the risk of being of the bad (weak) type.

4. Formal analysis

We will illustrate our argument with the help of a simple formal model. To this purpose, we consider a society whose individuals, when sick, have access to health care and to health insurance. The insurance is organized as expenditure reimbursement, as it is usually the case for health insurance (although in principle we could think of some kind of indemnity, this is not an optimal solution in the case of health, because it is extremely difficult to predict in advance the loss suffered for a given adverse event). However, not to include inessential complication, in our analysis we will rule out moral hazard, i.e. the tendency of insurance to inflate expenditure, by assuming that only care whose benefit exceeds cost is provided to the individual; this implies that full coverage is optimal and it is never optimal to have deductibles or co-insurance.

In order to make the framework of analysis as simple as possible, we consider a society of risk averse individuals living for two periods, $t = 1, 2$. Let the loss incurred by the individual h in period $t = 1$ be represented by a realization of the random variable $X_h \geq 0$ (we can think of the loss as the cost of medical care needed to secure the an adequate level of health) while the loss during period $t = 2$ is given by Y_h, which we define as $Y_h = ZX_h$, i.e. the product of X_h and a random variable $Z \geq 0$ with non-negative values and $\mathrm{E}[Z] > 1$, representing the (uncertain) growth of expected loss between the first and the second period. We assume that variables X_h for different individuals are statistically independent (hence they are not correlated).

However, crucial to our analysis is the assumption that the rate of growth Z is common to all individuals, as it represent the system-wide effect of improvements in medical technology. Because of the common component Z, second period losses Y_h are not independent, although the conditional distributions $Y_h|Z$ are once again independent.

Individuals are heterogeneous in that $X_h \sim F(.|\theta_h)$ is distributed differently for different individuals. However, we assume that the parameter representing individual characteristics θ_h is initially (before period 1) unknown both to the individual and the insurer; θ_h, the

"type" of the individual, can be thought of as the realization of a random variable θ whose distribution in the population is commonly known. The fact that individuals have no information advantage over insurer means that asymmetric information is not an issue in our model.

We will proceed by considering first the outcome in case short term insurance contracts are negotiated period by period. Next, we consider the ideal situation where a long term contract is available at the beginning of the first period covering the loss of both periods. Then we discuss why we expect that such a contract will not be available in a competitive market.

4.1. Short term insurance contracts

Based on the information available, at the beginning of period 1 insurance contracts will take into account for each individual the unconditional probability of X, or $\hat{F}(.) = \int F(.|\theta)dG(\theta)$.

To simplify notation, we indicate by $\bar{x}_h$ the expected value of X_h, i.e. the expected value conditional on θ_h, and $\bar{x}$ as the unconditional expected value. Le latter corresponds to average loss/expenditure in the population.

Because ex ante all individuals appear identical in terms of risk, we expect that, in the first period, in a competitive market, insurance will be offered at an actuarially fair premium $\bar{x}$. This is possible because X_h are independent random variables, hence the law of large numbers applies in this case. At that price, due to risk aversion, all individuals will buy full coverage.

Things are made more complicated in the second period by the assumption that, at the end of the first period, the "type" θ_h of all individuals is revealed to insurers and the individuals themselves. One explanation of this assumption is that past behaviour makes it possible to estimate the individual level of risk.

Moreover, we assume that at the beginning of period $t = 2$, when a new round of insurance is negotiated, the realization of Z is known to the parties.

As a consequence, it is possible to base the price of insurance for individual h in the second period on the individual distribution of health expenditure ZX_h. We have the following:

Proposition 1. *In the second period, an individual h will be offered insurance at the actuarially fair premium* $E[Y|\theta_h, Z] = Z\bar{x}_h$ *and at that premium he/she will buy full insurance.* □

An important thing to note is that now the premium is different for different individuals, reflecting differences in risks. We will return on this below.

4.2. Long term contracts

Although the individual is able to fully insure against the individual risk of being sick, such outcome implies that in the second period his/her premium will be adjusted according the information about the type of the individual θ_h. This means that, from an ex ante perspective, the individual is exposed to the risk that his/her level of expenditure is high. Because a risk averse individual would pay to insure against this risk, we wonder if there is an arrangement which is able to provide such insurance.

A simple way to see this point is to consider what the individual would do if he/she had access to a long term contract covering both period one and two. It must be noted that such a contract should include a credible commitment not to revise its terms in the second period even when there is a mutual benefit.

We first observe that a risk averse individual would find it attractive a long term contract such that the second period premium is equal to the unconditional expected cost $\mathrm{E}[ZX] = \mathrm{E}[Z]\bar{x}$. Namely, such an ideal contact would be always better than a sequence of short term contracts. The latter would imply a second period payment equal to $Z\bar{x}_h$, hence from an ex ante perspective, the mean payment would be:

$$\mathrm{E}[Z]\mathrm{E}_\theta[\bar{x}_h] = \mathrm{E}[Z]\bar{x} \tag{1}$$

while the variance, which implies a loss for a risk averse individual, would be (given independence between Z and X)

$$\mathrm{V}[Z\bar{x}_h] = \mathrm{V}[Z]\mathrm{V}_\theta[\bar{x}_h] + \mathrm{V}[Z]\mathrm{E}_\theta[\bar{x}_h]^2 + \mathrm{V}_\theta[\bar{x}_h]\mathrm{E}[Z]^2. \tag{2}$$

We explore here the possibility that a long term contract can be beneficial for individuals, i.e. that it can reduce the variance (2).

To this purpose, we first consider the case of an uncontingent contract, where the premium is set in advance for both periods.

In this regards, a difficulty arises from the circumstance that Y_h are correlated because of Z. As a consequence, the law of large numbers does not apply in this case: the insurer is not able to reduce the risk by pooling it across the whole population, as a high realization of Z will determina a high level of expenditure for all.

Note that, while a risk averse individual will accept to buy insurance as long as the insurance premium does not exceed to the average loss — plus a risk premium which depends on the degree of risk aversion — the insurer will be able to avoid the risk of default only by setting the premium at a level so high that the probability that the average loss $Z\bar{x}$ exceeds the premium is reasonably close to zero.

In other words, given a target probability of default ϵ, the premium π must satisfy:

$$\text{Prob}\{Z\bar{x} > \pi\} < \epsilon \tag{3}$$

and

$$\pi \leq \text{E}[Z]\bar{x} + \delta \text{V}[ZX]. \tag{4}$$

To explore the nature of the equilibrium, it would be necessary to specify in more detail the consequences of a default of the insurer for the insured. A possibility is that, in case of default, the reimbursement paid in case the individual is sick is reduced. In this case, the possibility of a high Z translates into less than full insurance coverage.

It is abstractly possible to imagine that, in case expected expenditures increase, individuals are required to supplement their initial payment with a further payment large enough to cover the additional cost of insurance. This would amount to a contingent contract, where the premium paid in the second period is made conditional on the realization of Z. However, this is not a realistic option in the context we have described; when se say that the parties "know" Z at the beginning of period 2, what we have in mind is that insurers have access to this information, which they incorporate in their market offers; in a competitive market, such information is provided to individuals. In the two period short term contracts considered above, such information, accessible to insurers, was revealed to all individuals through the competitive offers of different insurers. It is not clear that something similar is possible in a market where long term contracts are negotiated. With the language of incomplete contract theory, we could say that the realization of Z is something *observable* but *not verifiable*, in the sense that it would be extremely difficult to write an explicit contract in period 1 where the amount of the premium depends on the best prediction of the aggregate level of expenditure at the beginning of period 2. No surprise it is not something we currently observe.

To be sure, something equivalent to a contingent contract could be obtained through ex post contracting, where we leave the parties free to renegotiate the terms of the insurance contract, including the premium, in the light of the information available and competing offers by other providers. However, in the case we will end up with something close to what we had for short term contracts, where the insurer has a clear incentive to discriminate against "good" and "bad" risks, and the "good" risks would themselves look for better terms than they had initially agreed. Hence, the possibility to "revise" ex post the term of the contract opens the door to attempt of competing insurer to cream skim the "good" risks, by offering them contracts low premia, while it is difficult to prevent the insurer of "bad" risks to make differentiated offerts to different individuals.

In short, we don't think that a contingent contract is practically viable in the context of a competitive market.

On the other hand, if the contract is not contingent and the insurer wants to minimize the risk of a default, the premium required is likely to be higher, possibly much higher, than the actuarially fair level represented by $\mathrm{E}[Z]\bar{x}$. This may imply that no individual will find it convenient to subscribe such a contract. They will prefer to opt for a short term contract.

In other words, the only alternative available with competitive markets seems to be short term contracts on one hand, involving renegotiation at period two, and uncontingent long term contracts, which however imply a premium higher than the expected loss, possibly so high that the individual can't find it convenient to subscribe.

5. Government intervention

The conclusion of the previous paragraph

6. Concluding remarks

In this paper we have provided a simple two period framework where we account for public intervention in an insurance market characterized by heterogeneity of risks and by the impossibility to provide long term insurance contract. The latter is explained by the presence of long term systematic risk.

Within the set of circumstances described, a competitive market fails to provide efficient insurance because, being forced to rely on short term contracts, individuals find no protection from reclassification risk, i.e. from the risk of an increase in premium in case their risk results to be high.

Moreover, contingent contract which are able to insure individual risk cannot be offered by the market due to the incentive to cream skim and select risk in the second period. Our conclusion is that, in such a situation, the provision of universal insurance is a second best solution, as it allow to come close to an optimal contingent contract.

We argue that such solution, although clearly illustrated by the case of health, can be more generally applied, so that it can represent a convincing account of the role of the state as a provider of insurance. What is remarkable of our explanation is that it does not rely on asymmetric information; this may be particularly relevant in a world where, due to the possibility to collect personal data through electronic devices, the notion of private information seems to become less and less significant.

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