Asymmetric Information – Adverse Selection Problem

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Abstract. The present paper makes an introduction in the contract theory starting with the definitions of asymmetric information and some of the problems that generate: moral hazard and adverse selection. We provide an insight of the latest empirical studies in adverse selection in different markets. An adverse selection model, based on Rothchild and Stiglitz is also present to give a perspective of the theoretical framework.

Keywords: asymmetric information, adverse selection model, efficient contracts

1. Introduction

A *contract* is a promise that two parts make and, where there are stated both parties' obligations for all possible situations. In particular, a contract includes the payment mechanism used to compensate the Agent for the effort he used to accomplish the objective of the contract. The contract is based only on *verifiable variables* that can be analyzed by an independent part, and which are a guarantee that the contract will be not be broken.

The contract parties' are called, in the scientific literature, a Principal and an Agent. There is a contractual relation between the principal and the agent, where the first contracts the later in order to work or to help him take a decision. A well known relation of this kind is the one between a manager (the agent) hired by a firm (the principal) to run the business. The manager's contract will specify the payment received by the agent, as well as his duties. The agent will decide whether he will sigh or not the contract offered to him by the principal and he cannot make a contra-offer – this situation is known as a *bilateral bargaining problem*. The agent will accept the contract only when his expected utility form the contract is larger then the utility he has when he doesn't sign the contract, known as reserve utility level. So, the principal is the party with all the bargaining power and he will decide the contractual terms.

In the Game Theory framework, the relation between a principal and an agent is a Steckelberg game, where the principal is the *leader* who offers the contract and the agent is the *follower* who accepts it or not.

If he decides not to sign the contract, the relation between the two doesn't take place and the problem is over. If the agent decides to accept the contract, according to the terms of the contract, he has to take certain actions.

The principal – agent relation has the following characteristics:
▪ The principal designs the contracts, he decides upon the effort level he expects from the agent and he pays him accordingly;
▪ The agents accepts or not the contractual terms and he makes the efforts he is expected to;
▪ The agent works or takes some actions for the principal.

Hence, the agent's objectives are opposite to the one of the principal: the salary is a plus for the agent but a minus for the principal while the agent's effort is a plus for the principal and a minus for the agent itself.

2. Asymmetric information – applications in insurance: literature review

The studies made till now or that are on their way to be finalized underline the most important problems in the insurance market. Millions of people in Europe have health or car insurances. The economic importance of this facts pressures over a better functioning of the insurance market. In this context, economists are concentrated over this subject, which is proved by the winning of Nobel Prize for Economics in 2001 by George Akerlof, Michael Spence and John Stiglitz. They received the prize for their research in markets with asymmetric information.

In economics and contract theory, an **information asymmetry** is present when one party to a transaction has more or better information than the other party. (This is also called a state of **asymmetric information**). Most commonly, information asymmetries are studied in the context of principal-agent problems. (http://en.wikipedia.org)

In order to analyze the asymmetric information, one can start with the hypothesis of perfect or symmetric information. So, all the parties that are included in an economic process and have access to the same amount of information are considered in an analysis.
Many economists, such as Arrow – Nobel Prize in 1972, underlined the impotance of the hypothesis of perfect information that can be found in most models. Using this information, the three economists that received the Nobel Prize in 2001 offer a better understanding of the market mechanisms. Their models can be used in different areas: industrial organization, economics of development, insurance or finance. These allow us to understand the institutions that can influence the negative effects of asymmetric information.

In 1996, the prize for Economics created by the Bank of Sweden for A Nobel was received by James Mirreless and William Vickery for their contributions to the incentive theory under asymmetric information.

Market theory in asymmetric information is based mostly on the studies of George Akerlof, Michael Spence and John Stiglitz. Their applications started with the traditional agricultural markets and were followed by studies on financial markets. They showed that the phenomena encountered on different markets can be better understood by adding the hypothesis of asymmetric information that asses that a market participant is more informed then another one. Examples are a car seller that knows better the car quality then the buyer, the insurants that know better their attitudes towards risk then the insurance company, etc.

Their work can be synthesized as it follows: Akerlof showed that asymmetric information can induce the presence of adverse selection in the market, Spence showed that informed agents can be determined to signal their private information to the uninformed agents and Stiglitz demonstrated that the less informed agents can get the information indirectly from the informed agents by offering them contracts that can be substituted one by the others in a transaction and auto-select the necessary information.

The asymmetric information in insurance market is a situation where the consumers are better informed then the insurers (Rothschild and Stiglitz, 1976). But, the insurance companies have a hole different opinion about the definition of asymmetric information, considering that the individuals have a limited experience while the statistic methods used to estimate their knowledge have progressed.

Adverse selection is a process that takes place when the individuals that are expected to lose must pay the same insurance premium while the individuals that are expected to win or lose less will chose not to be insured so the insurance company will only have clients that will bring her great losses. Due to the presence of adverse selection, the insurance markets encounter a lot of difficulties. (World Bank, 2000)

Moral hazard is the loss suffered by an insurance company after a probable luck of honesty or prudence from the insurants. (*www.cogsci.princeton.edu*)

The hypothesis of the adverse selection show that, while the insurance companies know better the risk, the insurants have certain personal information, unobserved by the insurance company, and which are relevant to find the risk.

Chiappori and Salanie (2000) state that it is possible the adverse selection can not be present in some insurance markets. Further more, if we assume that the insurance companies are better informed about the insurant risk, and then the former are better informed about the risk. Based on this, Villeneuve (2000) proposed an analysis of better informed insurants that will study the way in which the information is transmitted.

The results of adverse selection and moral hazard were studied in different situations that are related to:
▪ Different market structure: monopoly, oligopoly and perfect competition (for instance: Arnott and Stiglitz (1991), Jack (1998))
▪ Different types scanning variables (Chernew et al (1999));
▪ Different time moments: static and dynamic insurance (Janssen şi Karamychey (2001));
▪ Different sources of agents' homogeneity: from the classic differences between random probabilities till the differences in the degree of risk aversion and the accidents flow (Eeckhouldt et al. (1988), Fluet (1992));
▪ Models specific to insurance markets based on genetic algorithms (Sellgren (2001)).

The presence of adverse selection and moral hazard in the insurance market was empirically tested. Wolfe and Goddeeries (1991) studied the demand of a certain type of life medical insurance, Medigat and discovered a very wick presence of adverse selection.

Pueltz and Snow (1994) tested the same this in the US car insurance market and they discovered that the agents with a large risk loving coefficient choose the insurance with a larger coverage, which is consistent to the adverse selection.

In 2001, Godfried studied the dental insurance demand in Holland, which was included in the standard medical insurance package in 1995. The conclusion was that the agents with a large inclination toward risk tend to buy a supplementary dental insurance. Other studies came to different conclusions.

Chiappori and Salanie (2000) studied the car insurance market in France and Cordon and Hendel (1999) studied the health insurance market. Cawley and Philipson (1999) studied the life insurance market in US. These studies showed that there is no explicit presence of adverse selection and moral hazard in these markets.

Similar studied were done by Dionne and Vanasse, Chiappori and Salanie (2000), Dionne, Gourieroux, and Vanasse (1997), Richaudeau (1999) and Dionne et al. (2001), some of them being interested by the car insurance market.

The life insurance market was also studied by Chiappori and Salanie (2003), Chiappori, Geoffard and Kyriadizou (1998), Cardon and Hendel (1998) as well as Hendel and Lizzeri (1999). Poterba and Finkelstein (2003) studied the annuity contracts and Chiappori (2000) made different attempts to distinguish between adverse selection and moral hazard in empiric tests.

At the moment, the asymmetric information is studied empirically and it brings the most interesting results that will lead to improvements of the theoretical models. Everything that is written our day on adverse selection and moral hazard is mainly a base for the future development of this domain.

3. The basic adverse selection model – Macho-Stadler, Castrillo (2005)

Based on Mirrlees (1971), Spence (1974), Mussa and Rosen (1978), Baron and Myerson (1982) and Guesnerie and Laffont (1984), Macho Stadler and Castrillo (2005) presented the adverse selection problem considering the general Principal-Agent model.

The principal is risk neutral and he hires an agent that can be neutral or risk adverse in order to work for him. It is assumed that the effort e will lead to a principal's expected profit $\Pi(e)$. The effort is assumed to be a verifiable variable and because the principal is risk neutral, the profit will be given by: $\Pi(e) = \sum_{i=1}^{n} p_i(e)x_i$, where x_i is the result that can be obtained by the principal with the probability $p_i(e)$ that depends by the effort e.

In order for the objective functions to be concave, it is assumed that $\Pi'(e) > 0$ and $\Pi''(e) < 0$.

The agent can be of different types and the principal cannot distinguish between these. The two types of agents (a "good" one, that is willing to work and a "bad" one that will work less) have only a different disutility function of the effort, $v(e)$ for the "good"| agent (or type 1) and $kv(e)$, where $k > 1$ for the "bad" agent (or type 2). The disutility given by a known level of effort is larger for the agent of type 2. This is why the type 1 agent will be considered to be the "good - G" or "bad - B" agent and the principal will pay less for the type B agent. Knowing these, the agents' utility functions will be:

$$U^G(w,e) = u(w) - v(e),$$
$$U^B(w,e) = u(w) - kv(e).$$

The optimum problem for the principal will consist in maximizing the expected profits under the condition that the agent will chose the contract accordingly to his type:

$$\max_{\left[(e^G, w^G)(e^B, w^B)\right]} q\left[\Pi(e^G) - w^G\right] + (1-q)\left[\Pi(e^B) - w^B\right]$$

$$\text{subject to} \quad u(w^G) - v(e^G) \geq \underline{U} \tag{1}$$
$$u(w^B) - kv(e^B) \geq \underline{U} \tag{2}$$
$$u(w^G) - v(e^G) \geq u(w^B) - v(e^B) \tag{3}$$
$$u(w^B) - kv(e^B) \geq u(w^G) - kv(e^G) \tag{4}$$

The first two restrictions show that the agents will chose the contracts that are destined to them and they are called participation constraints. The last two constraints are the conditions that make each type of agent to accept their own contract instead of the contract intended for the other type. These are known as the auto-selection or incentive constraints.

Before solving the optimum problem, the inequality (1) can be obtained from the relations (2) and (3):

$$u(w^G) - v(e^G) \geq u(w^B) - v(e^B) \geq u(w^B) - kv(e^B) \geq \underline{U},$$

so we can eliminate it. Actually, this is a characteristic of adverse selection problems. The only participation constraint important for the principal is the one corresponding to the less efficient agent because this agent has an incentive constraint that shows he wishes to be considered as if he is of the either type. The participation constraints show that all types of agents have at least the reserve utility, even the efficient agent.

We can observe that for the participation constraints to be saturated, the optimal contracts must be the one where the most efficient agent works with high level of effort: $e^G \geq e^B$, because relations (3) and (4) show that:

$$v(e^G) - v(e^B) \leq u(w^G) - u(w^B) \leq k[v(e^G) - v(e^B)] \tag{5}$$

that leads to $v(e^G) \geq v(e^B)$, because k>1.

Let λ, μ and δ be the Lagrangean multipliers associated to the constraints (3), (4) and (5). The Lagrangean associated to the optimum problem is:

$$L(e^G, e^B, w^G, w^B, \lambda, \mu, \delta) = q[\Pi(e^G) - w^G] + (1-q)[\Pi(e^B) - w^B]$$
$$+ \lambda[u(w^B) - kv(e^B) - \underline{U}]$$
$$+ \mu[u(w^G) - v(e^G) - u(w^B) + v(e^B)]$$
$$+ \delta[u(w^B) - kv(e^B) - u(w^G) + kv(e^G)]$$

The first order conditions are:

$$\frac{\partial L(.)}{\partial w^G} = 0 \Leftrightarrow -q + \mu u'(w^G) - \delta u'(w^G) = 0 \Leftrightarrow \mu - \delta = \frac{q}{u'(w^G)} \tag{6}$$

$$\frac{\partial L(.)}{\partial w^B} = 0 \Leftrightarrow -(1-q) + \lambda u'(w^B) - \mu u'(w^B) + \delta u'(w^B) = 0 \Leftrightarrow$$
$$\lambda - \mu + \delta = \frac{1-q}{u'(w^B)} \tag{7}$$

$$\frac{\partial L(.)}{\partial e^G} = 0 \Leftrightarrow q\Pi'(e^G) - \mu v'(e^G) + \delta k v'(e^G) = 0 \Leftrightarrow$$
$$\mu - \delta k = \frac{q\Pi'(e^G)}{u'(w^B)} \tag{8}$$

$$\frac{\partial L(.)}{\partial e^B} = 0 \Leftrightarrow (1-q)\Pi'(e^B) - \lambda k v'(e^B) + \mu v'(e^B) - \delta k v'(e^G) = 0 \Leftrightarrow$$
$$\lambda k - \mu + \delta k = \frac{(1-q)\Pi'(e^B)}{v'(e^B)} \tag{9}$$

Summing the relations (6) and (7), we get:

$$\lambda = \frac{q}{u'(w^G)} + \frac{1-q}{u'(w^B)} > 0 \tag{10}$$

and adding the relations (8) and (9) we get:

$$k\lambda = \frac{q\Pi'(e^G)}{v'(e^G)} + \frac{(1-q)\Pi'(e^B)}{v'(e^B)} > 0 \tag{11}$$

that shows the constraint (2) has to be satisfied: $u(w^B) - kv(e^B) = \underline{U}$, and the less efficient agent will get exactly the reservation utility $\underline{U}$.

From the relation (6), $\mu > 0$.

We assume that $\mu = 0 \Rightarrow \delta = -\frac{q}{u'(w^G)} < 0$, which is impossible. From here, we obtain the relation (3) to be satisfied:

$$u(w^G) - v(e^G) = u(w^B) - v(e^B),$$

which means that the most efficient agent will get exactly the reservation utility.

Before we present the characteristics of the optimal contract, we shall demonstrate that it can't be optimal to offer a contract that requires the same effort from both types of agents. If $e^G = e^B$, then from the relation (5) we get: $u(w^G) - u(w^B) = 0$ and, accordingly, it results that $w^G = w^B$.

From the relations (10) and (11), we can get:

$$\lambda = \frac{1}{u'(w)} = \frac{\Pi'(e)}{kv'(e)},$$

for some values of e and w, common to both types of agents. Finally, the equations (6) and (8) lead to:

$$\mu = \frac{q}{u'(w)} + \delta = q\lambda + \delta$$

$$\mu = \frac{q\Pi'(e)}{v'(e)} + k\delta = qk\lambda + k\delta = k(q\lambda + \delta),$$

which is impossible because $\mu \neq k\mu$ for $k > 1$ and $\mu > 0$. As a conclusion, the optimal menu of contracts will include two different contracts for the agent.

Because $e^G > e^B$, it is not possible that both relations (3) and (4) will be saturated simultaneously. $k > 1$ shows that one of the two inequalities from the expression (5) must be strict. The equation (3) can be rewritten:

$$u(w^G) - v(e^G) = u(w^B) - v(e^B) = u(w^B) - kv(e^B) + (k-1)v(e^B)$$
$$= \underline{U} + (k-1)v(e^B)$$

which means that the contract is destined to the most efficient agent and it allows him to get a profit strictly higher then his reservation utility. Because $\delta = 0$, the equations (6) and (8) show that:

$$\frac{1}{u'(w^G)} = \frac{\Pi'(e^G)}{kv'(e^G)},$$

which is the condition that makes the contract (e^G, w^G) to be chosen and is called the efficiency constraint. Finally, knowing that the relation (7) is equivalent to:

$$-\mu = \frac{1-q}{u'(w^B)} - \lambda,$$

And the equation (9) can be rewritten using the equation (10):

$$\frac{(1-q)k}{u'(w^B)} + \frac{q(k-1)}{u'(w^G)} = \frac{(1-q)\Pi'(e^B)}{v'(e^B)},$$

that leads to:

$$\frac{q(1-k)}{(1-q)} \cdot \frac{v'(e^B)}{u'(w^G)} + \frac{kv'(e^B)}{u'(w^B)} = \Pi'(e^B)$$

which is the forth condition that defines the optimal contract. *q.e.d.*

Hence, the optimum menu of contracts $\left\{\left(e^G, w^G\right), \left(e^B, w^B\right)\right\}$ is defined by the following equations:

$$u(w^G) - v(e^G) = \underline{U} + (k-1)v(e^B)$$

$$u(w^B) - kv(e^B) = \underline{U}$$

$$\Pi'(e^{G^*}) = \frac{v'(e^{G^*})}{u'(w^{G^*})}$$

$$\Pi'(e^{B^*}) = \frac{kv'(e^{B^*})}{u'(w^{B^*})} + \frac{q(k-1)}{(1-q)}\frac{v'(e^B)}{u'(w^G)}$$

Conclusions

The optimal menu of contracts $\left\{\left(e^G, w^G\right), \left(e^B, w^B\right)\right\}$ has the following characteristics, as they are presented by Macho-Stadler and Castrillo:

1. the participation constraint is satisfied only for the agent with larger costs, while the other agent receives an *information rent* $(k-1)v\left(e^B\right)$. This means that the most efficient agent receives a higher utility then the reservation utility due to the private information. This is a characteristic of the adverse selection contracts;
2. the incentive constraint for the most efficient agent is satisfied for the optimal solution while the incentive constraint for the other type of agent is not;
3. the efficiency constraint is satisfied for the type G agent. This property is known as the "no distortion at top" constraint and it shows that, for an adverse selection problem, the only efficient contract is the one for the agent nobody wants. If the agent is *risk neutral*, the efficiency constraint is not a function of w^G because $u'\left(w^G\right)$ is a constant. So, $e^G = e^B$. If the agent is *risk adverse*, than the efficiency constraint is a function of w^G. The optimal payment w^G in an adverse selection problem is different of w^{G^*}, which leads to $e^G \neq e^{G^*}$. But, the contract designed for the G type agent is efficient in both cases.
4. a distortion is included in the efficiency constraint for the B type agent. This is explained by the fact that a contract $\left(e^B, w^B\right)$ is designed to be less attractive to G type agent. By this distortion, the principal loses some part of his efficiency due to the B type agent but he pays informational rents smaller than the ones to G type agent. This trade between these two effects is favorable to the distortion process.

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