THE MORAL HAZARD AS FORM OF THE INFORMATION ASYMMETRY: THE CONTINUOUS CASE

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ABSTRACT

This paper draws up one of the most known form of information asymmetry manifestation, the moral hazard in the continuous case situation. General aspects regarding the informational asymmetry are emphasized here, the model hypotheses and the stages of running a contract between the Principal and the Agent, passing from the symmetrical information case towards the asymmetrical information.

Keywords: moral hazard model, asymmetric information, Principal-Agent model, optimal contracts, effort level.

INTRODUCTION

The information asymmetry has always interceded at concluding a deed, when one of the participants owned more or better information as comparing to his or her partners. An example refers to a transaction with a second hand car, when the seller has obviously more information about the car as comparing to the buyer. As concerns the insurances, when concluding a Civil Auto Liability policy, the contrary situation takes place: the policy's seller doesn't know all the necessary elements related to buyer, meaning his or her carefulness, the qualities of a driver, his or her experience as driver etc.

Recent realities have shown a tendency of reducing the informational asymmetry, especially due to the huge opportunities of information that the Internet offer.

The asymmetry of information emphasizes three types of demonstration:

The Moral Hazard (Risk)

At which the Principal cannot know the level of effort submitted by the Agent, and for this reason, some incitements;

The Adverse Selection (Anti-Selection)

Situation where the Agent owns information that the Principal hasn't known before concluding the contract. In this case, the Principal will propose to the Agent more contracts and, depending on the contract chosen, he will get to know the information hidden by the Agent;

Signaling

Implies that one of the parts disposes of hidden information, but having such behavior, the information will be shared to the other part, also.

HYPOTHESES OF THE MORAL HAZARD MODEL IN THE CONTINUOUS CASE

The moral hazard concept occurred for the first time in the XVIIthcentury, but it had a deeply negative feature for a long time, thus involving a false pretenses behavior. The first approach close to the current optics as regards the moral hazard belongs to Pauly (1968), which proved the following: if the insurance type affects the request, the total insurance contract will no longer be Pareto optimal. Zeckhauser (1970) built the first model of moral hazard applied to the sanitary system, being followed by Spence and Zeckhauser (1971), with a general form of the moral hazard model.

The moral hazard occurs when the Principal cannot observe the effort submitted by the Agent or when he receives information as concerns some private data after signing the contract. Therefore, the participants own the same data, but just before concluding the contract. The informational asymmetry has occurred during its progress. The stages of running a contract in moral hazard conditions are the following:

a. The Principal proposes to the Agent a contract;

b. The Agent accepts (if he agrees) the contract;

c. The Agent accomplishes an effort (which cannot be checked by the Principal);

d. The type determines the state;

e. The action of the Agent will be ended with a result, for which this will be rewarded.

We consider that the progress of the gross income of the Principal is described by a continuous random variable $\tilde{x}$, whose sharing is determined by a variable of effort e, controlled by the Agent, but which the Principal cannot see. We will denote by F(x,e) the repartition of the variable $\tilde{x}$ and by f(x,e) its density, assuming that the support of the distribution does not depend upon e.

We assume that the Agent is neutral or has risk aversion, having the utility function strictly increasing, concave and additively separable, under the form of $U(W,e)=U(W)-V(e)$ (therefore, $U'>0, U''\le 0$, $V'>0, V''>0$).

The Principal will be also neutral or of risk aversion, with the utility function strictly increasing and concave, depending upon the level of result and by the wage already paid to the Agent, B(X-W). We will obviously achieve $B'>0, B''\le 0$.

The Agent will accept the contract proposed by the Principal, if the utility expected will reach at least the level of reserve $\underline{U}$.

We assume that the result x depends upon the effort submitted e and upon the random nature states, meaning ω: x=x(e, ω) , with $x\in[x_1,x_2]$.

As concerns the acceptance, the Agent will chose the effort e submitted, the nature being involved by its random state ω and will be remunerated by a wage of $W:[x_1,x_2]\to \mathbb{R}_+, W=W(x)$.

THE CASE OF SYMMETRICAL INFORMATION

If the Principal can notice and control the effort e, accomplished by the Agent, we reach the situation of symmetrical information model. The contract that will be proposed to the Agent will be represented by the optimal solution of the maximization issue, as regards the estimation of utility, in conditions of participation restriction conditions:

$$\begin{cases} \max\limits_{e,W(x)} E\left(B\left(\tilde{x}-W(\tilde{x})\right)\right) \\ E\left(U\left(W(\tilde{x})\right)-V(e)\right)\ge \underline{U} \end{cases}.$$

The Lagrange function for the previous function will be represented by:

$$L(W,e,\lambda)=\int_{x_1}^{x_2}\left[B\left(x-W(x)\right)\cdot f(x,e)\right]dx+\lambda\cdot\left(\int_{x_1}^{x_2}\left[U\left(W(x)\right)\cdot f(x,e)\right]dx-V(e)-\underline{U}\right).$$

The first order conditions as regards the wage W and the effort e, are the following:

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$$\begin{cases} \dfrac{\partial L}{\partial W}=0 \\ \dfrac{\partial L}{\partial e}=0 \end{cases} \Rightarrow \begin{cases} -B'\left(x-W(x)\right)+\lambda\cdot U'\left(W(x)\right)=0 \\ \int_{x_1}^{x_2}\left[B\left(x-W(x)\right)\cdot f_e'(x,e)\right]dx+\lambda\left(\int_{x_1}^{x_2}\left[U\left(W(x)\right)f_e'(x,e)\right]dx-V'(e)\right)=0 \end{cases} \Rightarrow$$

$$\Rightarrow \begin{cases} \dfrac{B'\left(x-W(x)\right)}{U'\left(W(x)\right)}=\lambda, \forall x\in[x_1,x_2) \\ \int_{x_1}^{x_2}\left[B\left(x-W(x)\right)\cdot f_e'(x,e)\right]dx+\lambda\cdot\int_{x_1}^{x_2}\left[U\left(W(x)\right)\cdot f_e'(x,e)\right]dx=\lambda\cdot V'(e) \end{cases} \quad . \quad \textbf{(1)}$$

The third condition of first order (as related to λ) $\dfrac{\partial L}{\partial \lambda}=0$ will ensure the saturation of the participation restriction.

The first condition of relationship **(1)**, as regards two random values $x, x'\in[x_1,x_2]$, can be written:

$$\frac{B'\left(x-W(x)\right)}{B'\left(x'-W(x')\right)}=\frac{U'\left(W(x)\right)}{U'\left(W(x')\right)}, \forall x, x'\in[x_1,x_2] \, .$$

This relationship signifies the optimal distribution of the risk between the two partners: the marginal rates of substitution for the income are equal, no matter the state of the nature. The second relationship specific to **(1)** can also be written:

$$\int_{x_1}^{x_2}\left(\left[B\left(x-W(x)\right)+\lambda\cdot U\left(W(x)\right)\right]\cdot f_e'(x,e)\right)dx=\lambda\cdot V'(e) \, .$$

This relationship can be seen by the equality between the marginal disutility of the effort (the left part) and the total marginal utility, weighted by λ, in conditions of saturating the participation restriction.

We will forwards analyze the way the incomes of the Agent and of the Principal related to the variation of result, in the situation when both partners have risk aversion.

Analyzing the first relationship of **(1)** we can write down

$$B'\left(x-W(x)\right)=\lambda\cdot U'\left(W(x)\right)$$

and, deriving as related to the result x, we deduct that:

$$B''\left(x-W(x)\right)\cdot\left(1-\frac{dW}{dx}\right)=\lambda\cdot U''\left(W(x)\right)\cdot\frac{dW}{dx} \, .$$

Replacing λ with the expression achieved in **(1),** we will achieve:

$$B''\left(x-W(x)\right)\cdot\left(1-\frac{dW}{dx}\right)=\frac{B'\left(x-W(x)\right)}{U'\left(W(x)\right)}\cdot U''\left(W(x)\right)\cdot\frac{dW}{dx}\Rightarrow$$

$$\Rightarrow B''\left(x-W(x)\right)-B''\left(x-W(x)\right)\cdot\frac{dW}{dx}=\frac{B'\left(x-W(x)\right)\cdot U''\left(W(x)\right)}{U'\left(W(x)\right)}\cdot\frac{dW}{dx}\Big|\cdot U'\left(W(x)\right)\Rightarrow$$

$$\Rightarrow B''(x-W(x))\cdot U'(W(x))-B''(x-W(x))\cdot U'(W(x))\cdot\frac{dW}{dx}=$$

$$=B'(x-W(x))\cdot U''(W(x))\cdot\frac{dW}{dx}\Rightarrow$$

$$\Rightarrow B''(x-W(x))\cdot U'(W(x))=$$

$$=\left[B''(x-W(x))\cdot U'(W(x))+B'(x-W(x))\cdot U''(W(x))\right]\cdot\frac{dW}{dx}\Rightarrow$$

$$\Rightarrow \frac{dW}{dx}=\frac{B''(x-W(x))\cdot U'(W(x))}{B''(x-W(x))\cdot U'(W(x))+B'(x-W(x))\cdot U''(W(x))}. \qquad \textbf{(2)}$$

Since both partners have risk aversion, their utility functions will be strictly increasing and strictly concave, and we will therefore achieve: $B'>0, B''<0, U'>0, U''<0$. We therefore reach that $\frac{dW}{dx}>0$, so that an increase of the result will determine (as it should be achieved) an increase of the Agent income.

Analyzing the Principal, his income is x-W(x), and therefore we will achieve $\frac{d}{dx}(x-W(x))=1-\frac{dW}{dx}>0$ (we used $\frac{dW}{dx}<1$, since the right part report of relationship **(2)** has the denominator higher than the nominator).

THE CASE OF ASYMMETRICAL INFORMATION (MORAL HAZARD)

We forwards assume that actions of the Agent are no longer observable by the Principal. Therefore, the effort e is chosen by the Agent, in order to maximize the estimated utility:

$$e\in\arg\max_{e'}\int_{x_1}^{x_2}\left(\left[U(W(x))-V(e')\right]\cdot f(x,e')\right)dx$$

And, the problem of optimization at the Principal's level will be the following:

$$\begin{cases} \max\limits_{e,W(\cdot)} E\left(B\left(\tilde{x}-W(\tilde{x})\right)\right) \\ E\left(U\left(W(\tilde{x})\right)\right)-V(e)\geq \underline{U} \\ e\in\arg\max\limits_{e'}\int_{x_1}^{x_2}\left(\left[U(W(x))-V(e')\right]\cdot f(x,e')\right)dx \end{cases}.$$

At this issue, one might notice the incitation restriction that is on its turn a problem of optimization, fact that can be solved in some hypothesis, as in the discrete situation, by using the method of first order approximation. We will replace the incitation restriction from the previous problem, with a condition of first order, thus reaching to the following issue:

$$\begin{cases} \max\limits_{e,W(\cdot)}\int_{x_1}^{x_2}\left[B(x-W(x))\cdot f(x,e)\right]dx \\ \int_{x_1}^{x_2}\left(\left[U(W(x))-V(e)\right]\cdot f(x,e)\right)dx\geq\underline{U} \\ \int_{x_1}^{x_2}\left[U(W(x))\cdot f_e'(x,e)\right]dx-V'(e)=0 \end{cases}. \qquad \textbf{(3)}$$

The Lagrange function for this problem will be the following:

$$L\left(e,W(\cdot),\lambda,\mu\right)=$$

$$=\int_{x_1}^{x_2}\left[B\left(x-W(x)\right)\cdot f(x,e)\right]dx+\lambda\cdot\left[\int_{x_1}^{x_2}\left(\left[U\left(W(x)\right)-V(e)\right]\cdot f(x,e)\right)dx-\underline{U}\right]+$$

$$+\mu\cdot\left(\int_{x_1}^{x_2}\left[U\left(W(x)\right)\cdot f_e'(x,e)\right]dx-V'(e)\right).$$

Writing down the first condition of first order, as related to the wage W, and the effort e, for the problem **(3),** we will deduct $\begin{cases}\dfrac{\partial L}{\partial W}=0\\ \dfrac{\partial L}{\partial e}=0\end{cases}$. From the first condition we notice that:

$$-B'\left(x-W(x)\right)\cdot f(x,e)+\lambda\cdot U'\left(W(x)\right)f(x,e)+\mu\cdot U'\left(W(x)\right)f_e'(x,e)=0\,\Big|:f(x,e)\neq 0\Rightarrow$$

$$\Rightarrow\frac{B'\left(x-W(x)\right)}{U'\left(W(x)\right)}=\lambda+\mu\cdot\frac{f_e'(x,e)}{f(x,e)}.$$

The second condition of first order can be written by:

$$\int_{x_1}^{x_2}\left[B\left(x-W(x)\right)\cdot f_e'(x,e)\right]dx+\lambda\cdot\left(\int_{x_1}^{x_2}\left[U\left(W(x)\right)\cdot f_e'(x,e)\right]dx-V'(e)\right)+$$

$$+\mu\cdot\left(\int_{x_1}^{x_2}\left[U\left(W(x)\right)\cdot f_{e^2}''(x,e)\right]dx-V''(e)\right)=0.$$

Using the second restriction of **(3)** we deduct:

$$\int_{x_1}^{x_2}\left[B\left(x-W(x)\right)\cdot f_e'(x,e)\right]dx+\mu\cdot\left(\int_{x_1}^{x_2}\left[U\left(W(x)\right)\cdot f_{e^2}''(x,e)\right]dx-V''(e)\right)=0.$$

Holmstrom and Shavell (1979)have shownthat if $F_e(x,e)\leq 0$ and $U''<0$ (the Agent has risk aversion), then $\mu>0$. In this situation, the distribution of risk is no longer Pareto-optimal. If the participative restriction is ex-post met, the Agent will achieve an estimated utility higher that the reserve utility $\underline{U}$ ($\underline{U}$ will be achieved only in unfavorable market conditions).

CONCLUSIONS

Concerning the continuous model, in the situation of the symmetrical information, the distribution of the risk between the two partners will be optimal: the marginal rates of substitution of the income are equal, no matter the state of the nature. If the information is asymmetrical, the distribution of risk will be no longer Pareto-optimal. If the participative restriction is ex-post satisfied, the Agent will achieve an estimated utility higher than the reserve utility $\underline{U}$ ($\underline{U}$ is achieved for only unfavorable market conditions).

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