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When trust fades...: Can optimal mechanisms for policy decisions always be designed?

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WHEN TRUST FADES... CAN OPTIMAL MECHANISMS FOR POLICY DECISIONS ALWAYS BE DESIGNED?

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Abstract

Governments must usually take policy decisions with an imperfect knowledge of the economic actors' type or the actors' effort level. These issues are addressed within the framework of classic adverse selection or moral hazard models. I discuss in this paper how would the government's and the economic actors' behavior change if relevant information is double asymmetric, that is, it is not just the government that has limited information about the agents' type or effort level, but the economic actors also lack perfect information about the government's trustworthiness.

Using the modeling tools of mechanism design I prove in the paper, that government – as principal – is only capable of applying “perverse” incentives towards the economic agents: it punishes well-behaving agents while it rewards the badly behaving ones. I apply the theoretical models to the regulatory issues of network industries, and specifically to the ICT industry.

JEL Codes: C73 (Stochastic games); D82 (asymmetric information, mechanism design)

Keywords: mechanism design, incentive theory, adverse selection, moral hazard, Bayesian games.

When trust evaporates... Can optimal mechanisms for policy decisions always be designed?*

1. INTRODUCTION

The issue this paper addresses is as follows: how does the economic actors' trust in the government's policy decisions affect the actors' economic performance? People use the notion of trust with a positive connotation in everyday life: if we have confidence in another person or in an institution then we expect that the behavior of the other party will have a beneficial impact upon our life. I define trust as a positive rather than a normative concept. Notably, I assume that economic actors have full confidence in government if it behaves according their expectations that are based on the government's preliminary announcement of its planned actions. The government's actions may equally have negative or positive consequences upon the economic agents.¹

A widely accepted but critical assumption among economists is that people always respond to the proper incentives. This would render the government's task easy in attaining certain policy objectives: it should apply the right incentives to induce the expected behavior from the economic agents. Government may be hampered in its effort to induce certain behavior from agents by the private information economic actors possess and would like to use for their own benefit. But what if information is not just asymmetric between economic actors and the government, but it is "double-asymmetric" in the sense that agents also lack relevant information about the government's intentions and actions? In other words, how can government induce trust and cooperation if economic actors do not have trustful and sufficient information? I shall address this issue on a fairly general level but the results of the analysis are easily applicable to very specific questions. For instance, can government induce the expected savings or tax-paying behavior of the economic agents by using the proper incentives? Can the desired consumption pattern or the use of the environment be induced by the right incentives? Or can the regulator induce the firms' voluntary information revelation in

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¹ On the relationship between trust and economic performance see, for instance, Ackerman-Rose, S. Kornai, J. and Rothstein, B. (2004), Arrow, K. (2006), Dasgupta, P. (2009), Coleman, J. (1990), Farrell, H. (2009), Györfy (2006), (2012), Luhmann, N. (1979), Zak, P. J. and Knack, S. (2001).

regulated markets? These and similar questions are discussed in the framework of “mechanism design.”

Papers in the realm of mechanism design usually depart from the assumption that asymmetric information between the economic actors and the “social planner” (the government or government agencies) is the main stumbling block on the road toward an efficient outcome of social welfare maximization. (See, for instance, Hurwicz (2008), Maskin (2008), Myerson (2008), and Mookherjee (2008)). “Mechanism designers” also assume that it is the government that does not have sufficient information about the predetermined characteristics of the economic actors—in the usual slang of economics, about the actors’ type—and about the actors’ behavior. In other words, the actors’ type is their private information, and government cannot monitor their effort level either. Economic actors, on the other hand, possess all the relevant information. Therefore they have an informational monopoly over government. Then the government’s problem is how to induce the economic agents so that the agents would reveal their private information and they would behave according to the government’s expectations.

The main issue of this paper is, how does the social game change if information is double asymmetric between government and economic agents? With double adverse selection or moral hazard, social welfare maximization becomes a much more difficult exercise if a reasonable solution for the social welfare maximization problem can be attained at all.²

If government and the economic actors face the double asymmetry of information the task of mechanism design becomes a much more complex exercise. I present two simple examples of social welfare maximization to demonstrate the complexity of the problem. In the first example, the government has but probabilistic knowledge of the economic actors’ type and the actors possess only probabilistic information about the government’s type. Agents can be “efficient” or “inefficient,” while government can be “trustful” or “mistrustful.” I shall label such a scenario “double adverse selection.”

In the second example I assume that government can be one of two types: it can be “trustful” or “mistrustful.” At the same time, government has insufficient knowledge about the effort level of the economic actors. Economic actors can exert high or low effort to fulfill the task government assigns to them.³ Such a setting is also a case for double-sided

² Mixed cases may also occur, where the government’s type and the agents’ effort level are unobservable by the other party, or vice versa.

³ The government’s and the agents’ type as well as the agents’ effort level could be represented by continuous variables. I limit the analysis to the simplest case, where the government or the agents can be one of two types, or the agents can exert only high or low effort, to keep the analysis tractable.

asymmetric information: the government cannot monitor the agents' effort level, while the agents do not know the government's type when they engage in a contract. I label the government trustful if it does what it previously announced and the agents expect from him to do. That is, it pays high remuneration for the agents' efficient outcome and low remuneration for the agents' inefficient outcome in the first example. In the second example, the government will be called trustful if it pays high benefit in case it observes high accomplishment from the agents and low benefit if it observes low accomplishment. The opposite will hold for a mistrustful government: it pays *less* for an efficient than for an inefficient outcome in the first case, and it pays *less* for a high than for a low accomplishment in the second example.

The structure of the paper is as follows: I give a brief literature review in Section 2. I present the model of double adverse selection in the Section 3. I discuss double information asymmetry as a Bayesian game in Section 4. I present the mixed model of the agents' unknown effort level and the government's unknown type in Section 5. Discussion and conclusion follow in Section 6.

2. A BRIEF LITERATURE REVIEW

The literature on double moral hazard and on double adverse selection is not very extensive. Romano (1994) analyzed double moral hazard in a resale price maintenance setting. He concluded that double moral hazard results in vertical externalities between firms, and optimal pricing can only be attained by fixing the minimum or the maximum price. Bhattacharyya and Lafontaine (1995) discussed double-sided moral hazard in a sharecropping or franchising environment. They found that linear contracts can be optimal in revenue or profit sharing. Kim and Wang (1998) assumed a risk averse agent and double moral hazard and showed that the optimal contract is non-linear, and it does not converge to a linear contract even if the risk aversion of the agent approaches zero. Agarwal (2002) proved that double moral hazard can best be contained by institutional arrangements as had been suggested by Coase. Aggarwal and Lichtenberg (2005) looked for an optimal pollution tax under double moral hazard and concluded that a first best optimum cannot be attained in such a setting. Besley and Ghatak (2005) assumed that principals and agents are mission-oriented as opposed to seeking maximum profits in a public bureaucracy or in a non-profit organization. They showed that matching the principals' and agents' preferences can improve organizational efficiency and lessen the impact of asymmetric information. Carrillo and Palfrey (2009) conducted

laboratory experiments and concluded that an anomalous equilibrium occurs between Bayesian players if one of them is weaker than the other: they will never compromise although an intermediate outcome could benefit both of them. Hun Seog (2010) argued that only inefficient equilibriums unfold between buyers and sellers in product markets in the presence of double adverse selection despite product warranties and the existence of a connected insurance market. Firms of different types offer either a pooling warranty to good and bad buyers, or good firms attract only bad buyers while bad firms equally sell to good and bad buyers.

3. DOUBLE ADVERSE SELECTION

Let us say that the government announces a policy measure that results in a gain of $S(q)$ to government (and to society) and a benefit $b(q)$ to each economic actor depending on the magnitude of the actor's accomplishment q . To further simplify the analysis I shall assume that economic actors have the same valuation of benefits and costs. Agents learn how large their benefit will be only after accomplishing the task the government assigns to them, but they know from the start that their benefit can be high, $b_E(q_E, q_{IE})$ or low, $b_{IE}(q_E, q_{IE})$, paid by government for an efficient and for an inefficient accomplishment, respectively. Their actual benefit will also depend on the government's type. Agents know that the government can be trusted with probability π or mistrusted with probability $1 - \pi$. On the other hand, the government lacks perfect information about the agents' type. It only knows that the agents can be efficient with probability ν or inefficient with probability $1 - \nu$.

Let us start with the agent's problem. I assume that the agent performs the task q with a linear cost function $C(q) = \theta q$, where the magnitude of her marginal cost θ indicates the agent's type: $\theta \in \{\theta_E, \theta_{IE}\}$, with $\theta_E < \theta_{IE}$. (I disregard fixed costs for the sake of simplicity, but this will not affect the essence of the analysis.) Hence, marginal cost can be low θ_E or high θ_{IE} indicating the agent's efficiency level. I also assume that the agent is risk neutral. Then her valuation U of benefit net of costs can simply be written as $U(b(q) - \theta q) = b(q) - \theta q$. Finally, I shall assume that the economic actor's reservation utility is normalized to zero: $U_0 = 0$.

Both types can choose a pure strategy of performing either the efficient outcome q_E or the inefficient outcome q_{IE} and receive the expected benefit of $\pi b_E + (1 - \pi)b_{IE}$ or

$\pi b_{IE} + (1 - \pi)b_E$, respectively, where b_E and b_{IE} are short for $b_E(q_E, q_{IE})$ and $b_{IE}(q_{IE}, q_E)$, and denote the economic actors' benefit for efficient and for inefficient accomplishment, respectively. However, economic actors can also choose a mixed strategy by randomizing between q_E and q_{IE} . For instance, if an efficient economic actor—knowing that the government can only be trusted with probability π —performs q_E with probability π and she accomplishes q_{IE} with probability $1 - \pi$, her expected benefit becomes: $(\pi^2 + (1 - \pi)^2)b_E + 2\pi(1 - \pi)b_{IE}$. Consequently, the economic actors will have different participation constraints (PC) and incentive compatibility constraints (IC) if they pursue a pure strategy than in case they opt for a mixed strategy. The PCs and the ICs for the efficient and for the inefficient agent who select a pure strategy become:⁴

For the *efficient agent*

$$(2a) \quad \pi(b_E - \theta_E q_E) + (1 - \pi)(b_{IE} - \theta_E q_E) = \pi b_E + (1 - \pi)b_{IE} - \theta_E q_E \geq 0 \quad (\text{PCEP})$$

$$(2b) \quad \pi b_E + (1 - \pi)b_{IE} - \theta_E q_E \geq \pi b_{IE} + (1 - \pi)b_E - \theta_E q_{IE} \quad (\text{ICEP})$$

For the *inefficient agent*

$$(2c) \quad \pi(b_{IE} - \theta_{IE} q_{IE}) + (1 - \pi)(b_E - \theta_{IE} q_{IE}) = \pi b_{IE} + (1 - \pi)b_E - \theta_{IE} q_{IE} \geq 0 \quad (\text{PCIEP})$$

$$(2d) \quad \pi b_{IE} + (1 - \pi)b_E - \theta_{IE} q_{IE} \geq \pi b_E + (1 - \pi)b_{IE} - \theta_{IE} q_E \quad (\text{ICIEP})$$

In case the economic actors choose a mixed strategy, the PCs and the ICs will be:⁵

- for the *efficient agent*

$$(3a) \quad \begin{aligned} & \pi[\pi(b_E - \theta_E q_E) + (1 - \pi)(b_{IE} - \theta_E q_E)] + (1 - \pi)[\pi(b_{IE} - \theta_E q_{IE}) + (1 - \pi)(b_E - \theta_E q_{IE})] = \\ & = (\pi^2 + (1 - \pi)^2)b_E + 2\pi(1 - \pi)b_{IE} - \pi\theta_E q_E - (1 - \pi)\theta_E q_{IE} \geq 0. \end{aligned} \quad (\text{PCEM})$$

(3b)

$$\begin{aligned} & \pi[\pi(b_E - \theta_E q_E) + (1 - \pi)(b_{IE} - \theta_E q_E)] + (1 - \pi)[\pi(b_{IE} - \theta_E q_{IE}) + (1 - \pi)(b_E - \theta_E q_{IE})] \geq \\ & \pi[\pi(b_{IE} - \theta_E q_{IE}) + (1 - \pi)(b_E - \theta_E q_{IE})] + (1 - \pi)[\pi(b_E - \theta_E q_E) + (1 - \pi)(b_{IE} - \theta_E q_E)] \end{aligned} \quad (\text{ICEM})$$

⁴ PCEP = participation constraint of the efficient agent with pure strategy; ICEP = incentive compatibility constraint of the efficient agent with pure strategy; PCIEP = participation constraint of the inefficient agent with pure strategy; ICIEP = incentive compatibility constraint of the inefficient agent with pure strategy.

⁵ PCEM = participation constraint of the efficient agent with mixed strategy; ICEM = incentive compatibility constraint of the efficient agent with mixed strategy; PCIEM = participation constraint of the inefficient agent with pure strategy; ICIEM = incentive compatibility constraint of the inefficient agent with mixed strategy.

that is:

$$\begin{aligned} & (\pi^2 + (1-\pi)^2)b_E + 2\pi(1-\pi)b_{IE} - \pi\theta_E q_E - (1-\pi)\theta_E q_{IE} \geq \\ & (\pi^2 + (1-\pi)^2)b_{IE} + 2\pi(1-\pi)b_E - (1-\pi)\theta_E q_E - \pi\theta_E q_{IE}; \end{aligned}$$

- for the *inefficient agent*

(3c)

$$\begin{aligned} & \pi[\pi(b_{IE} - \theta_{IE} q_{IE}) + (1-\pi)(b_E - \theta_{IE} q_{IE})] + (1-\pi)[\pi(b_E - \theta_{IE} q_E) + (1-\pi)(b_{IE} - \theta_{IE} q_E)] = \\ & (\pi^2 + (1-\pi)^2)b_{IE} + 2\pi(1-\pi)b_E - \pi\theta_{IE} q_{IE} - (1-\pi)\theta_{IE} q_E \geq 0. \end{aligned}$$

(PCIEM)

(3d)

$$\begin{aligned} & \pi[\pi(b_{IE} - \theta_{IE} q_{IE}) + (1-\pi)(b_{IE} - \theta_{IE} q_{IE})] + (1-\pi)[\pi(b_E - \theta_{IE} q_E) + (1-\pi)(b_{IE} - \theta_{IE} q_E)] \geq \\ & \pi[\pi(b_E - \theta_{IE} q_E) + (1-\pi)(b_{IE} - \theta_{IE} q_E)] + (1-\pi)[\pi(b_{IE} - \theta_{IE} q_{IE}) + (1-\pi)(b_E - \theta_{IE} q_{IE})] \end{aligned}$$

(ICIEM)

that is:

$$\begin{aligned} & (\pi^2 + (1-\pi)^2)b_{IE} + 2\pi(1-\pi)b_E - \pi\theta_{IE} q_{IE} - (1-\pi)\theta_{IE} q_E \geq \\ & (\pi^2 + (1-\pi)^2)b_E + 2\pi(1-\pi)b_{IE} - (1-\pi)\theta_{IE} q_{IE} - \pi\theta_{IE} q_E. \end{aligned}$$

Participation constraints (2a) and (2c), and incentive compatibility constraints (2b) and (2d) are the usual constraints one can encounter in the discussions of one-sided adverse selection or signaling problems where one party has private information about his type. These constraints just state that in case an efficient (inefficient) agent behaves as his type dictates, his expected benefit minus his type dependent cost cannot be smaller than his reservation utility, and an efficient (inefficient) type cannot achieve higher net benefit by pretending of being inefficient (efficient).

The remaining participation and incentive compatibility constraints—the PCs are given in equations (3a) and (3c), and the ICCs in (3b) and (3d)—are the really interesting ones with double adverse selection. PCs (3a) and (3c) show that in case an efficient (inefficient) agent knows that the government can only be trusted with probability π and mistrusted with probability $1-\pi$, and he will randomize his accomplishment according to these probabilities, he cannot be worse off than by accomplishing nothing and accepting his reservation utility. The ICCs (3b) and (3d) make sure that an efficient (inefficient) agent—who knows that the government can be trusted only with probability π —cannot gain less by randomizing his accomplishment according to the known probabilities and his type than by randomizing as if he were the other type.

It is not obvious which strategy will the economic actors choose. The agents' benefit with the pure and with the mixed strategy cannot be easily compared for they will have different accomplishments in the two cases and those will influence their net benefit (benefit minus costs). We shall return to this question after we solve the government's welfare maximization problem. If agents choose the pure strategy, the PC of the inefficient agent (equation 2c) and the ICC of the efficient agent (equation 2b) will bind, and the well-known results from "simple" adverse selection obtains:

$$(4) \quad S'(q_E) = \theta_E, \text{ and } S'(q_{IE}) = \theta_{IE} + \left(\frac{\nu}{1-\nu} \right) \Delta\theta,$$

where $\Delta\theta = \theta_{IE} - \theta_E$.

In case the actors opt for the mixed strategy, the PC of the inefficient agent (equation 3c) and the ICC of the efficient agent (equation 3b) will bind, but the government's welfare maximization becomes a more tedious exercise than with the agents' pure strategies. From the binding constraint we have:

$$(5) \quad (\pi^2 + (1-\pi)^2)b_{IE} + 2\pi(1-\pi)b_E = \pi\theta_{IE}q_{IE} + (1-\pi)\theta_{IE}q_E, \text{ and}$$

(6)

$$\begin{aligned} & (\pi^2 + (1-\pi)^2)b_E + 2\pi(1-\pi)b_{IE} - \pi\theta_Eq_E - (1-\pi)\theta_Eq_{IE} = \\ & (\pi^2 + (1-\pi)^2)b_{IE} + 2\pi(1-\pi)b_E - (1-\pi)\theta_Eq_E - \pi\theta_Eq_{IE} \Rightarrow \\ & \Rightarrow (\pi^2 + (1-\pi)^2)b_E + 2\pi(1-\pi)b_{IE} = \\ & = \pi\theta_Eq_E + (1-\pi)\theta_Eq_{IE} + \pi\theta_{IE}q_{IE} + (1-\pi)\theta_{IE}q_E - (1-\pi)\theta_Eq_E - \pi\theta_Eq_{IE} = \\ & = (2\pi-1)\theta_E(q_E - q_{IE}) + \pi\theta_{IE}q_{IE} + (1-\pi)\theta_{IE}q_E. \end{aligned}$$

Now we turn to the discussion of the government's social welfare maximization problem. I assume that the government has a quasi linear valuation function of the agents' accomplishment minus benefits—that government allocates to the agents for their accomplishment—in the form of $S(q) - b(q)$ with the usual properties: $S'(q) > 0$ and $S''(q) < 0$, where q measures the magnitude of the agent's accomplishment, and $b(q)$ is the benefit paid to the agent by government. Thus, the government's social welfare maximization problem is as follows:

$$(7) \quad \max_{q_E, q_{IE}, b_E, b_{IE}} \left\{ \nu \left[\pi S(q_E) + (1-\pi)S(q_{IE}) - (\pi^2 + (1-\pi)^2)b_E - 2\pi(1-\pi)b_{IE} \right] \right. \\ \left. + (1-\nu) \left[(1-\pi)S(q_E) + \pi S(q_{IE}) - 2\pi(1-\pi)b_E - (\pi^2 + (1-\pi)^2)b_{IE} \right] \right\}.$$

Substituting the results from equations (5) and (6) into the government's social welfare maximization problem in equation (7) yields:

(8)

$$\max_{q_E, q_{IE}} \left\{ \begin{aligned} & [\nu\pi + (1-\nu)(1-\pi)]S(q_E) + [\nu(1-\pi) + (1-\nu)\pi]S(q_{IE}) \\ & - \nu[(2\pi-1)\theta_E + (1-\pi)\theta_{IE}]q_E + (\pi\theta_{IE} - (2\pi-1)\theta_E)q_{IE} \\ & - (1-\nu)\theta_{IE}[(1-\pi)q_E + \pi q_{IE}] \end{aligned} \right\}.$$

Proposition 1. *With double adverse selection between the government and the economic agents, government will provide the agents of both types with “perverse” incentives: it distorts the level of the efficient outcome downwards, while it will distort the inefficient outcome level upwards from the Pareto-efficient level.*

Proof. Solving equation (8) for welfare maximum obtains:

$$(9a) \quad S'(q_E) = \frac{\nu(2\pi-1)\theta_E + (1-\pi)\theta_{IE}}{\nu\pi + (1-\nu)(1-\pi)} = \theta_E + \left(\frac{(1-\pi)}{\nu\pi + (1-\nu)(1-\pi)} \right) \Delta\theta \quad \text{for the efficient}$$

outcome, which is below its first best level, and

$$(9b) \quad S'(q_{IE}) = \frac{\pi\theta_{IE} - \nu(2\pi-1)\theta_E}{\nu(1-\pi) + (1-\nu)\pi} = \theta_{IE} - \left(\frac{\nu(2\pi-1)}{\nu(2\pi-1) - \pi} \right) \Delta\theta \quad \text{for the inefficient outcome,}$$

which is above the level of first best optimum if $\pi > 1/2$ and $\nu > \frac{\pi}{2\pi-1}$ or $\pi < 1/2$ and

$$\nu < \frac{\pi}{2\pi-1}, \text{ for } \left(\frac{\nu(2\pi-1)}{\nu(2\pi-1) - \pi} \right) \Delta\theta \text{ will then be positive in equation (9b). } Q.e.d.$$

As can be seen from equations (9a) and (9b), neither the efficient nor the inefficient agent will conduct his task at its “first best” level, where the marginal benefit from welfare optimization would equal the marginal cost of the economic actors’ activities.⁶ Thus, the outcome of social welfare maximization will be away from its Pareto efficient state. What is even more striking, the solution of the double adverse selection problem may provide “perverse” incentives to the economic actors. Notably, the extent of the efficient agent’s activity will be distorted *downwards*—that is, the efficient agent will accomplish less than socially optimal, for

$$\left(\frac{(1-\pi)}{\nu\pi + (1-\nu)(1-\pi)} \right) \Delta\theta \text{ in equation (9a) is always positive. The activity level of the}$$

inefficient agent will always be distorted *upwards* under fairly general conditions. Another important result of the above analysis is that the size of the output distortion is a decreasing

⁶ Recall that with the agents’ pure strategies, the efficient outcome will be at its first best level, while government will distort the inefficient outcome *downwards* from its first best level, as can be seen in equation (4).

function of trust in government (π) as can be seen from equations (9a) and (9b). That is, the more agents trust their government the smaller the diversion from their first best outcome becomes.

It may also be a feasible solution for the economic actors that efficient agents choose a mixed strategy while the inefficient agents play their pure strategy. Then the PC of the inefficient agent—as given in equation (2c) will bind. The binding IC of the efficient agent will be:

(10)

$$\begin{aligned} (\pi^2 + (1-\pi)^2)b_E + 2\pi(1-\pi)b_{IE} - \pi\theta_E q_E - (1-\pi)\theta_E q_{IE} &= (1-\pi)b_E + \pi b_{IE} - \theta_E q_{IE} \\ &= (1-\pi)b_E + \pi b_{IE} - \theta_{IE} q_{IE} + \Delta\theta q_{IE} = \Delta\theta q_{IE}. \end{aligned}$$

Substituting these results into the government's optimization problem yields:

$$(11) \max_{q_E, q_{IE}} \{ \nu [\pi S(q_E) + (1-\pi)S(q_{IE}) - \pi\theta_E q_E - (1-\pi)\theta_E q_{IE} - \Delta\theta q_{IE}] + (1-\nu)[S(q_{IE}) - \theta_{IE} q_{IE}] \}.$$

The first order conditions are as follows:

$$(12a) S'(q_E) = \theta_E,$$

$$(12b) S'(q_{IE}) = \frac{\theta_{IE} - \nu\pi\theta_E}{1 - \nu\pi}.$$

The efficient agent will accomplish her task at the first best level as can be seen from equation (12a). The accomplishment of the inefficient agent will be distorted downwards as in “simple” adverse selection, for $\frac{\theta_{IE} - \nu\pi\theta_E}{1 - \nu\pi} > \theta_{IE}$. But the distortion will be *smaller* than in simple adverse selection as can be seen by comparing (12b) and equation (4). That is, the efficient agent can secure a larger information rent for herself with a mixed strategy than with a pure strategy if the inefficient agent chooses his pure strategy.⁷

We may conclude this part of the analysis that even the usual second best solution of the social welfare maximization problem cannot be attained if the economic actors do not possess perfect information of the government's trustworthiness. In the presence of double adverse selection the efficient outcome will be below, while the inefficient outcome will be above the socially optimal level of accomplishments. The usual second best solution—where the efficient agents produce at their first best level while the government distorts the production of the inefficient ones downwards—can only be attained if government can fully be trusted.

⁷ The opposite of the above strategy mix, that is when the efficient agent chooses a pure while the inefficient agent a mixed strategy could only work if $\pi < 1/2$. Since the inefficient agent could only collect zero net utility at maximum in both cases, we may assume that he will not bother with a mixed strategy.

4. DOUBLE ASYMMETRIC INFORMATION AS A BAYESIAN GAME

Double asymmetric information problems can also be regarded as Bayesian games and we can solve the task of social welfare maximization by looking for Bayesian Nash equilibrium(s) of the game.⁸ The question is whether we can avoid the trap of “perverse” incentives in a Bayesian game that we encountered before. I shall show that the answer to this question is far from being obvious.

We retain all the assumptions about the economic agents’ risk neutrality and about the government’s and the agents’ probabilistic knowledge of different types. Hence, it is common knowledge that the agents can be efficient with probability ν or inefficient with probability $1 - \nu$, and the government can be trusted with probability π or mistrusted with probability $1 - \pi$. I shall look for explicit solutions of the agent’s utility maximization and the government’s welfare maximization problem.

I discuss that case first when both agent types choose their mixed strategy. Then I briefly outline the case when both types choose their relevant pure strategies. Next, I present the case when the efficient agent applies a mixed, while the inefficient agent a pure strategy. Finally, I describe the inverse situation, when the efficient agent plays her pure, while the inefficient one his mixed strategy.

The optimization problem of the efficient agent with a mixed strategy is as follows:

$$(13a) \quad \max_{q_E, q_{IE}} \left\{ (\pi^2 + (1 - \pi)^2) b_E(q_E, q_{IE}) + 2\pi(1 - \pi) b_{IE}(q_E, q_{IE}) - \pi\theta_E q_E - (1 - \pi)\theta_E q_{IE} \right\},$$

while the inefficient agent will optimize the following expected utility function:

$$(13b) \quad \max_{q_E, q_{IE}} \left\{ (\pi^2 + (1 - \pi)^2) b_{IE}(q_E, q_{IE}) + 2\pi(1 - \pi) b_E(q_E, q_{IE}) - \pi\theta_{IE} q_{IE} - (1 - \pi)\theta_{IE} q_E \right\}.$$

The first order conditions of maximum utility for the efficient agent are:

(14a)

$$\begin{aligned} (\pi^2 + (1 - \pi)^2) \frac{\partial b_E(q_E, q_{IE})}{\partial q_E} + 2\pi(1 - \pi) \frac{\partial b_{IE}(q_E, q_{IE})}{\partial q_E} - \pi\theta_E &= 0; \\ (\pi^2 + (1 - \pi)^2) \frac{\partial b_E(q_E, q_{IE})}{\partial q_{IE}} + 2\pi(1 - \pi) \frac{\partial b_{IE}(q_E, q_{IE})}{\partial q_{IE}} - (1 - \pi)\theta_E &= 0. \end{aligned}$$

The first order conditions for the inefficient agent obtain:

(14b)

⁸ András Simonovits suggested that I should discuss the social welfare maximization problem with double adverse selection in a Bayesian game framework.

$$\begin{aligned} (\pi^2 + (1-\pi)^2) \frac{\partial b_{IE}(q_E, q_{IE})}{\partial q_{IE}} + 2\pi(1-\pi) \frac{\partial b_E(q_E, q_{IE})}{\partial q_{IE}} - \pi\theta_{IE} &= 0; \\ (\pi^2 + (1-\pi)^2) \frac{\partial b_{IE}(q_E, q_{IE})}{\partial q_E} + 2\pi(1-\pi) \frac{\partial b_E(q_E, q_{IE})}{\partial q_E} - (1-\pi)\theta_{IE} &= 0. \end{aligned}$$

The government's social welfare maximization problem is the same as in equation (7) above:

$$(15) \quad \max_{q_E, q_{IE}, b_E, b_{IE}} \left\{ \nu \left[\pi S(q_E) + (1-\pi)S(q_{IE}) - (\pi^2 + (1-\pi)^2)b_E - 2\pi(1-\pi)b_{IE} \right] + (1-\nu) \left[(1-\pi)S(q_E) + \pi S(q_{IE}) - 2\pi(1-\pi)b_E - (\pi^2 + (1-\pi)^2)b_{IE} \right] \right\}.$$

PROPOSITION 2. *If both agent types play their mixed strategy, a mistrustful government will distort the efficient outcome downwards, while the inefficient outcome upwards from their first best optimum level, as with double adverse selection.*

PROOF. We can solve the government's maximization problem by substituting the results from equations (14a) and (14b) into the first order conditions of equation (15).

$$(16a) \quad \nu \pi S'(q_E) + (1-\nu)(1-\pi)S'(q_E) - \nu \pi \theta_E - (1-\nu)(1-\pi)\theta_{IE} = 0; \text{ and}$$

$$(16b) \quad \nu(1-\pi)S'(q_{IE}) + (1-\nu)\pi S'(q_{IE}) - \nu(1-\pi)\theta_E - (1-\nu)\pi\theta_{IE} = 0.$$

After collecting terms we have:

$$(17a) \quad S'(q_E) = \frac{\nu \pi \theta_E + (1-\nu)(1-\pi)\theta_{IE}}{\nu \pi + (1-\nu)(1-\pi)} \text{ for the efficient outcome; and}$$

$$(17b) \quad S'(q_{IE}) = \frac{\nu(1-\pi)\theta_E + (1-\nu)\pi\theta_{IE}}{\nu(1-\pi) + (1-\nu)\pi} \text{ for the inefficient outcome.}$$

It can be seen from equations (17a) and (17b) that the efficient outcome will be *smaller*, while the inefficient outcome will *larger* in a Bayesian game than the first best outcomes. But the distortions will be smaller in a Bayesian game than under double adverse selection and with the agents' mixed strategies. Q.e.d.

If the economic actors choose their type-dependent pure strategy, they will both produce at their first best level:

$S'(q_E) = \theta_E$, and $S'(q_{IE}) = \theta_{IE}$, as can be easily obtained from solving the agents' and the government's optimization problem:

$$(18a) \quad \max_{q_E, q_{IE}, b_E, b_{IE}} \left\{ \nu [S(q_E) - \pi b_E - (1-\pi)b_{IE}] + (1-\nu) [S(q_{IE}) - (1-\pi)b_E - \pi b_{IE}] \right\};$$

$$(18b) \quad \max_{q_E} \{ \pi b_E + (1 - \pi) b_{IE} - \theta_E q_E \} \text{ for the efficient agent, and}$$

$$(18c) \quad \max_{q_{IE}} \{ \pi b_{IE} + (1 - \pi) b_E - \theta_{IE} q_{IE} \} \text{ for the inefficient agent.}$$

If the efficient actor plays her mixed strategy while the inefficient actor his pure strategy, we have:

$$(19) \quad \max_{q_E, q_{IE}, b_E, b_{IE}} \left\{ \begin{aligned} & \nu [\pi S(q_E) + (1 - \pi) S(q_{IE}) - (\pi^2 + (1 - \pi)^2) b_E - 2\pi(1 - \pi) b_{IE}] \\ & + (1 - \nu) [S(q_{IE}) - (1 - \pi) b_E - \pi b_{IE}] \end{aligned} \right\}.$$

Using the results from equation (14a) and noticing that the first order condition of equation

$$(2c) \text{ yields: } \pi \frac{\partial b_{IE}(q_E, q_{IE})}{\partial q_{IE}} + (1 - \pi) \frac{\partial b_E(q_E, q_{IE})}{\partial q_{IE}} = \theta_{IE}, \text{ we ultimately get:}$$

$$(20) \quad S'(q_E) = \theta_E \text{ and } S'(q_{IE}) = \frac{(1 - \nu)\theta_E + \nu(1 - \pi)\theta_{IE}}{1 - \nu\pi}.$$

As can be seen in (20), the efficient outcome will be at its first best level, while the inefficient outcome will *exceed* its first best optimum in this Bayesian game.

Finally, in case the efficient agent plays her pure strategy while the inefficient agent chooses his mix strategy, the government's optimization problem will be:

$$(21) \quad \max_{q_E, q_{IE}, b_E, b_{IE}} \left\{ \begin{aligned} & \nu [S(q_E) - (1 - \pi) b_E - \pi b_{IE}] \\ & + (1 - \nu) [(1 - \pi) S(q_E) + \pi S(q_{IE}) - (\pi^2 + (1 - \pi)^2) b_{IE} - 2\pi(1 - \pi) b_E] \end{aligned} \right\}.$$

The first order conditions of (21) yield:

$$(22) \quad S'(q_E) = \frac{\nu\theta_E + (1 - \nu)(1 - \pi)\theta_{IE}}{\nu + (1 - \nu)(1 - \pi)} \text{ and } S'(q_{IE}) = \theta_{IE}.$$

As can be easily seen from (22), the inefficient outcome will be at its first best level, while the efficient outcome will be *smaller* than its first best.

Which strategy of the options described above will the efficient and the inefficient agent choose? It will depend on the functional form of $S(q)$, $b(q)$ and $c(q)$, that is, on the government's valuation function and on the benefit and cost functions of the agents. What we may say as a general conclusion, mixed strategies will always bring a distortion into the Bayesian game of the economic actors and the government. The distortions will move in the same direction as under double adverse selection, but they will be smaller in size in the former than in the latter case.

5. THE AGENTS' MORAL HAZARD WITH THE GOVERNMENT'S UNKNOWN TYPE

Now we turn to the third scenario where a mixed adverse selection-moral hazard situation unfolds. Assume that government assigns a task to the economic actors the fulfillment of which requires effort from the agents. An agent can decide whether she exerts high or low effort when fulfilling her task.⁹ The cost of effort is given by $\psi(e)$ where e stands for the effort level of the agent. The cost of high effort is $\psi(e) = \psi$, while I normalize the cost of low effort to zero. An agent's accomplishment can be high (q_H) or low (q_L). The agents' accomplishment is related to, but it is not solely determined by their effort. Other factors of the economic environment can also have an impact on the outcome. Government can observe the agents' accomplishment, but it is not capable of monitoring their effort. Government only knows the conditional probabilities of different outcomes with different effort levels. Notably, the accomplishment can be high with probability $\Pr(q_H|e_H) = \nu_H$ if the agent's effort was high, or the outcome can be low with probability $\Pr(q_L|e_H) = 1 - \nu_H$ despite the agent's high effort. The agent's accomplishment can be high with probability $\Pr(q_H|e_L) = \nu_L$ although she exerted low effort, or her accomplishment can be low with probability $\Pr(q_L|e_L) = 1 - \nu_L$ if she exerted low effort. We shall assume that $\nu_H > \nu_L$ which simply states that the probability of having high outcome is larger with high than with low effort. I assume that government prefers high to low effort from the economic actors.

The economic actors also lack perfect information about the government's type. They only know that the government can be trusted with probability π or it can be mistrustful with probability $1 - \pi$.

It is a well-known result of the moral hazard literature¹⁰ that with simple moral hazard and with risk neutral agents the first best optimum can always be attained. In case the agents are risk averse while government is risk neutral, the government faces a trade-off between efficiency and information rent that it pays to the agents in order to induce high effort from them. With risk neutral agents and high effort the agents' valuation of benefits net of effort costs becomes: $U(b(q), \psi(e)) = \nu_H b_H + (1 - \nu_H) b_L - \psi$, where b_H and b_L stand for high and for low benefits, respectively. Now we need to find the agents' participation and incentive

⁹ The agents' effort level could be a continuous variable in a general framework. I assume two effort levels in order to simplify the algebra, but without any loss of the results' generality.

¹⁰ See, for instance, Laffont and Martimort (2002), p. 154.

compatibility constraints which is not as straightforward as with simple moral hazard. An agent who exerts high effort can expect net benefit:

$$(23) \quad v_H [\pi b_H + (1 - \pi) b_L] + (1 - v_H) [(1 - \pi) b_H + \pi b_L] - \psi,$$

for the government can only be trusted with probability π . The agent's net benefit with low effort becomes:

$$(24) \quad v_L [\pi b_H + (1 - \pi) b_L] + (1 - v_L) [(1 - \pi) b_H + \pi b_L].$$

If government wants to induce high effort from the agents, the agents' participation constraint becomes:

$$(25) \quad v_H [\pi b_H + (1 - \pi) b_L] + (1 - v_H) [(1 - \pi) b_H + \pi b_L] - \psi \geq 0.$$

The agents' incentive compatibility constraint will be:

$$(26) \quad \begin{aligned} & v_H [\pi b_H + (1 - \pi) b_L] + (1 - v_H) [(1 - \pi) b_H + \pi b_L] - \psi \geq \\ & \geq v_L [\pi b_H + (1 - \pi) b_L] + (1 - v_L) [(1 - \pi) b_H + \pi b_L], \end{aligned} \quad \text{or}$$

$$\Delta v (2\pi - 1) (b_H - b_L) - \psi \geq 0,$$

where $\Delta v = v_H - v_L$.

What contract menu should the government offer to the agents? Government can find the optimal menu of contracts by solving the following welfare maximization problem subject to constraints (25) and (26).

$$(27) \quad \max_{u_H, u_L} \{ v_H [S_H - \pi b_H - (1 - \pi) b_L] + (1 - v_H) [S_L - (1 - \pi) b_H - \pi b_L] - \psi \}.$$

Government can attain maximum welfare if the benefits disbursed to economic actors for effort are the smallest. Consequently, both the participation constraint and the incentive compatibility constraint will bind. Thus, we can find the optimal benefits paid to the agents by government by solving the system of equations (25) and (26). The optimal benefits obtain:

$$(28a) \quad b_H = \psi + \frac{[(1 - v_H)\pi + v_H(1 - \pi)]\psi}{\Delta v (2\pi - 1)} = \left(\frac{\pi}{\Delta v (2\pi - 1)} - \frac{v_L}{\Delta v} \right) \psi;$$

$$(28b) \quad b_L = \psi + \frac{[(1 - v_H)\pi + v_H(1 - \pi) - 1]\psi}{\Delta v (2\pi - 1)} = - \left(\frac{(1 - \pi)}{\Delta v (2\pi - 1)} + \frac{v_L}{\Delta v} \right) \psi.$$

With "simple" moral hazard the economic actors would accrue the following high or low benefit, respectively:

$$(29) \quad b_H = \left(\frac{1 - v_L}{\Delta v} \right) \psi \text{ and } b_L = - \left(\frac{v_L}{\Delta v} \right) \psi. ^{11}$$

Comparing equations (28a) and (28b), and the equations in (29) immediately shows that the high benefit a not fully trusted government must pay for high accomplishment will be above the benefit that would have been paid with simple moral hazard, while low benefit paid by a not fully trustful government will be smaller than the low benefit that would be paid by government with simple moral hazard. Consequently, a not fully trusted government will be even less inclined to induce high effort from risk-averse economic actors than a trustful government. At the same time, the probability that economic actors receive a high benefit for high effort will be smaller with a distrustful than with a trustful government, for $v^H > v^H \pi + (1 - v^H)(1 - \pi)$ will always hold. Consequently, actors will not be strongly tempted to exert high effort either. The final result of the economic actors' moral hazard and a distrustful government will be a poorer economic performance and a larger social welfare loss than in case a fully trusted government wants to induce high effort from the actors.

6. CONCLUSIONS

I have shown in this paper that in the presence of information asymmetry between a government and the economic agents – when the government has only probabilistic knowledge of the agents' type or about their effort level, while the economic actors do not possess perfect information about the trustworthiness of their government – the government will apply perverse incentives toward the economic actors. Double adverse selection, or the Bayesian game between the government and the agents, or the presence of moral hazard on the agents' side and adverse selection on the government's side will result in a smaller than Pareto-optimal accomplishment of the efficient agents, or of the agents who exert high effort, while the inefficient agents, or the agents with low effort will accomplish more than what would be Pareto-optimal for society.

How can countries avoid the trap of double information asymmetry? The only way to do so is to eliminate the problem of low trust in government and in other legal institutions. I emphasize that the examples I outlined above are just simplified versions of the complex issues governments face. Increasing the level of trust and cooperation in economic decision

¹¹ Notice that with a fully trustful government the optimal benefits will be the same as in Laffont and Martimort (2002), p. 160.

making requires first of all credibility and commitment on the government's part. Trust and willingness for cooperation are deeply embedded social norms in any country. Only then can we expect a sustainable change in the basic social institutions and in deeply embedded social-cultural norms when economic agents see a change in the government's and other leading institutions' behavior.

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