FSA Institute Discussion Paper Series

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Tomoya Nakamura

DP 2011-5

September, 2011

Financial Research Center (FSA Institute)
Financial Services Agency
Government of Japan
3-2-1 Kasumigaseki, Chiyoda-ku, Tokyo 100-8967, Japan

<FSA Institute Discussion Paper Series DP2011-5 (September, 2011)>

Credit Rationing, Earnings Manipulation, and Renegotiation-Proof Contract*

Tomoya Nakamura†
Financial Services Agency (FSA Institute), Government of Japan

Abstract

This paper considers the situation where an manager borrows the funds from an investor and carries out long-term project with credit rationing problem. If the manager has myopic preference, credit rationing problem will be compounded by renegotiation depending on earnings signal. Moreover, we compare the transparent accounting system and the opaque one. If the parties can renegotiate the initial contract, credit rationing problem will be more relaxed in the opaque system than the transparent one.

Keywords: Credit rationing; Earnings manipulation; Renegotiation; Managerial myopia

JEL classification: D82, E51, G34, J33

*We thanks Hiroshi Osano, Tadashi Sekiguchi, and the participants of the Monetary Economics Workshop at Osaka University and the Japanese Economic Association Autumn Meeting 2010 at Chiba University. The views expressed in this paper are those of the authors and do not necessarily reflect the views of the Financial Services Agency or the FSA Institute.

†E-mail address: tomoya.nakamura@fsa.go.jp

1 Introduction

In recent years, we have met many accounting scandals by well-known firms. Then, the transparency of accounting information have been discussed lively. In such discussions, there is a general presumption that higher transparency of accounting information alleviates the agency problem and is beneficial to credit market. It may be true in many situations.

However, some economic theory suggest that it is not always true. Axelson and Baliga (2009) find that opaque financial system sometimes attains Pareto improving allocation. They investigate a situation where a manager has the long-term project with moral hazard, and an investor puts her funds on it. After moral hazard stage, manager obtains earnings signal regarding the outcome of his long-term project. They define *transparent* accounting system as the situation where both of parties can observe the signal. On the other hand, they define *opaque* one as the situation where only manager can observe the signal. Then, if the parties can renegotiate initial contract depending on the signal, the opaque system can sometimes alleviate a credit rationing problem compared to the transparent one by using the logic of Akerlof's lemon market.

Axelson and Baliga (2009) did not examine credit rationing problem. Hence, this study extend the model of Holmstrom and Tirole (1996) to two-period model, and introduce the logic of Axelson and Baliga (2009) into it. Then, we can know that the logic of Axelson and Baliga (2009) does not always hold in credit rationing problem. However, we find that the opaque system is better for the parties under the conditions that the probability of success is low but the precision of signal is high enough.

Our opaque policy suites for the drug discovery industry. It is difficult to judge whether research and development of the drug will be success in the time of initial investment. However, we have high technology of clinical test . This can be interpreted as earnings signal, that is, we have high precision of signal. In these industry, the opaque system will be better than transparent one.

2 The model

An manager has a long-term project which requires fixed investment I. He also has asset $A < I$ initially. To implement the project, the manager must borrow $I - A$ from investor. The long-term project yields verifiable income $R > 0$ in the case of success or no income in the case of failure. The probability of success regarding the project is determined by manager's unobservable behavior $e \in \{b, m\}$. Behaving $(e = b)$ yields probability $p_s > 0$

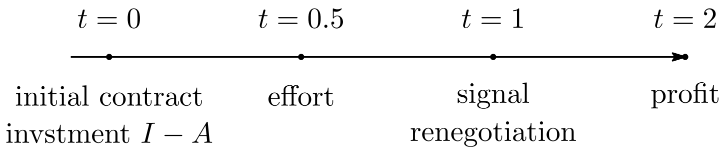

Figure 1: timeline

of success and no private benefit to the manager. Misbehaving ($e = m$) leads to profit zero with certainty but yields private benefit B to the manager.

We assume that the manager and the investor are risk neutral. However, they differ in patience. The investor is indifferent between early consumption and late one,

$$u_I(c_1, c_2) = c_1 + c_2, \tag{1}$$

where c_t is consumption at period $t \in \{1, 2\}$. On the other hand, the manager is impatient, that is,

$$u_E(c_1, c_2) = c_1 + \beta c_2, \quad \text{where } 0 < \beta < 1. \tag{2}$$

We can take β for opportunity cost of manager as in Aghion et. al. (2004) or Axelson and Baliga (2009)[1].

We assume that $pR - I > 0 = B - I$ for simplicity. Hence, the project has positive net present value if the manager behaves, but has zero if the manager misbehaves. This means that, as long as the manager behave, it is preferable to carry out the project socially. Additionally, we set $p(R|b)R < \frac{1+\beta}{\beta}I$ for the technical requirement.[2]

After the manager chooses his effort, but before the profit is realized, the manager receives signal $s \in \{h, \ell\}$ regarding the profit. Conditional on profit, the signal is distributed as follows;

$$p(h|y = R) = p > \frac{1}{2}, \qquad p(\ell|y = R) = 1 - p$$
$$p(h|y = 0) = 1 - p, \qquad p(\ell|y = 0) = p > \frac{1}{2}$$

where $p \in (0, 1)$.

[1]For example, consider the situation that the idea occurs to the manager at $t = 1$. If the $t = 1$ compensation scheme is not designed to transfer the money from the investor to the manager, the manager lose an opportunity to carry out the new project. This cost is measured by β. On the other hand, we will assume that the investor has all of bargaining power in this paper. So it is natural that he has the many investment project constantly. That is, there are no opportunity cost for the investor; $\beta = 1$. Another way of interpretation of β is the inefficiency of money. If the investor transfers one dollar both $t = 1, 2$, the payoff of $t = 1$ is bigger than that of $t = 2$. That is, $t = 2$ transfer has inefficiency.

[2]If the expected profit is so high, it is always optimal to implement the project. To focus on interesting situations, we impose this assumption.

Investor receives profit R in compensation for investment, and pays transfers w_1 at $t = 1$ and w_2 at $t = 2$ to the manager.

Here, we define the sort of contract for sharing the project profit. We assume that if the project will be success, once the investor receives all profit R in compensation for investment and pays transfers w_1 at $t = 1$ and w_2 at $t = 2$ to the manager for encouraging his effort. Moreover, we define the contract $w_1 > 0$ and $w_2 = 0$ as short-term contract, $w_1 = 0$ and $w_2 > 0$ as long-term contract, and $w_1 > 0$ and $w_2 > 0$ as mixed contract. Through this paper, we assume that the manager is protected by limited liability in all kind of contract forms.

Finally, timeline is as follow: (1) the parties sign an initial contract, (2) Manager put his effort on the project, (3) the earnings signal realize, and if possible, investor offers new contract, and (4) the output realize and the parties carry out the agreed contract.

3 Full-Commitment Benchmark

Assume that investor as well as manager can observe the signal s and that the initial contract cannot be renegotiated. The investor can use the two information, signal and output. Hence, the contract can be written by $\{w_1(s), w_2(y, s)\}_{s\in\{\ell,h\},y\in\{0,R\}}$. Assume that the investor has all of bargaining power. Hence we solve for the contract problem that minimize investor's payoff subject to the manager's incentive compatible constraint, limited liability constraint, and the both parties' participation constraint.[3]

Note that the optimal contract problem should be based on $\{w_1(s), w_2(y, s)\}_{s\in\{\ell,h\},y\in\{0,R\}}$. However, we can easily show that it is sufficient to think only about $\{w_1(h), w_2(R)\}$.[4] Then, the problem is

$$\min_{w_1(h),w_2(R)} \; p(h|b)w_1(h) + p(R|b)w_2(R) \tag{3}$$

$$\text{s.t.} \quad p(h|b)w_1(h) + \beta p(R|b)w_2(R) \geq p(h|m)w_1(h) + B \tag{ic_f}$$

$$p(R|b)R - \big[p(h|b)w_1(h) + p(R|b)w_2(R)\big] \geq I - A \tag{ir_f}$$

$$w_1(h) \geq 0, \;\; w_2(R) \geq 0. \tag{ll}$$

The lowest that encourages the manager to behave is (w_1^*, w_2^*) that satisfies binding case of (ic_f) . Note that this system is linear so that the solutions are one of two extremes, short-term contract or long-term contract. Hence, from (ic_f), short-term and long-term

[3] We assume $B = I$. Then, we can easily show that manager's participation constraint is always satisfied. So, we can neglect this constraint.

[4] See Axelson and Baliga (2009).

contracts must satisfy

$$w_1(h) \geq w_1^s \equiv \frac{B}{p(h|b) - p(h|m)} \quad \text{and} \quad w_2(R) \geq w_2^\ell \equiv \frac{B}{\beta p(R|b)}, \tag{4}$$

respectively. The expected payments from the investor to the manager are

$$w^s = p(h|b)\frac{B}{p(h|b) - p(h|m)}, \quad \text{and} \quad w^\ell = p(R|b)\frac{B}{\beta p(R|b)}. \tag{5}$$

To focus on the interesting cases, we assume that the long-term contract is cheaper than short-term one, $w^s > w^\ell$. Equivalently,

$$\beta \geq \underline{\beta} \equiv 1 - \frac{p(h|m)}{p(h|b)}. \tag{6}$$

Then the optimal contract is $w_2^*(R) > 0$ and the other transfers are zero. Substituting optimal contract into (ir_f) and solving for initial asset A, we have

$$A \geq A^* \equiv \frac{B}{\beta} - [p(R|b)R - I]. \tag{7}$$

If the manager has $A < A^*$ initially, then he faces credit rationing.

Because both parties are risk neutral and this initial contract is efficient in the viewpoint of risk-sharing, the parties have no incentive to renegotiate regarding risk-sharing. However, they have different patience. So, if investor transfer the same amount of money to the manager, then earlier payment improve manager's payoff. Hence the investor may think that paying the expected value of w_2^* in advance lower the total expected payment. This is the reason to consider the renegotiation. First we think about renegotiation problem under transparent accounting system and next under opaque system.

4 Renegotiation with transparent system

Suppose that after the signal is observed by the both parties, the investor can propose a new contract, that is, renegotiation. This contract is accepted by the manager if it weakly improves the manager's payoff compared to initial contract.

Define $\{\tilde{w}_1, \tilde{w}_2\}$ as any initial contract that the moral-hazard problem is not occured. Remember that both parties are risk-neutral but the manager is more impatient than the investor. Hence, if the investor offer the new contract $w_1(s) = \beta p(\cdot|\cdot,\cdot)\tilde{w}_2(\cdot,\cdot)$ and $w_2(\cdot,\cdot) = 0$ in place of initial contract, the manager weakly accept it and the investor can improve his payoff. This means that $w_1(\cdot) \geq w_2(\cdot,\cdot) = 0$ is optimal. That is, only short-term contract is renegotiation-proof. Then, we can focus our interest on short-term contract at the time of initial contract design.

The renegotiation-proof initial contract is the solution of following problem;

$$\min_{w_1(s),w_2(y,s)} \quad p(h|b)w_1(h) + p(\ell|b)w_1(\ell) \tag{8}$$

$$\text{s.t.} \quad p(h|b)w_1(h) + p(\ell|b)w_1(\ell) \geq p(h|m)w_1(h) + p(\ell|m)w_1(\ell) + B \tag{ic}$$

$$p(R|b)R - \big[p(h|b)w_1(h) + p(\ell|b)w_1(\ell)\big] \geq I - A \tag{ir}$$

We can easily show that the optimal contract is $w_1(h) > w_1(\ell) = 0$. From incentive compatibility constraint, the lowest transfer that encourage the manager work is

$$w_1(h) > w_1^t(h) \equiv \frac{B}{p(h|b) - p(h|m)}. \tag{9}$$

substituting this result into investor's participation constraint, we have

$$A \geq A^s \equiv \frac{p(h|b)}{p(h|b) - p(h|m)}B - [p(R|b)R - I]. \tag{10}$$

Our interest is whether the renegotiation effect the credit rationing problem. Comparing A^s with A^*, we have $A^s > A^*$ because the long-term contract is cheaper than short-term one. That is, the renegotiation worsen the credit rationing problem.

If the party can commit initial contract fully, the investor must follow it. But if the investor can offer the new contract after observing the signal, he is tempted by early payment that lower the total payment. This means that renegotiation-proof initial contract is short-term contract. Any contract without short-term contract cannot be well off the renegotiation-proof contract. Hence, it is sufficient that we focus our interest on short-term contract only. Note that short-term contract is more expensive than long-term one. This means that the investor must pay more and her payoff is lower. So the investor cannot lend the fund to the manager who has lower initial asset.

Proposition 1. *If the investor can offer the new contract at $t = 1$ in the case of $w_2(\cdot, \cdot) > 0$, then the investor will be tempted by early payment. So the renegotiation-proof contract should be short-term contract that is more expensive than long-term one. As a result, renegotiation-proof contract will be worsen.*

5 The effect of Information opaqueness

Next we consider the situation that only manager can observe the signal, that is, manager is not required to show his information. We assume that manager can send the earnings report $r \in \{h, \ell\}$. If the the investor can design the contract that the manager is willing to tell the truth, this report is informative. Axelson and Baliga (2009) show that the solutions of the contract under opaque system are (i) $w_1(h) = w_1(\ell) = \bar{R}_1$ if $w_2(R,h) = 0$, or (ii) $w_1(\ell) = w_1(h) + \beta p(R|\ell, b) w_2(R, h)$ if $w_2(R,h) > 0$.

In the case of $w_1(h) = w_1(\ell) = \bar{R}_1$, there is no incentive compatible contract without $B = 0$. However, we can design the incentive compatible contract if $w_2(R,h) > 0$. The problem is such that

$$\min_{w_1(\ell), w_2(R,h)} E\big[w_1(r) + w_2(y,r)\big] \tag{11}$$

$$\text{s.t.} \quad p(\ell|b)w_1(\ell) + p(h|b)w_1(h) + \beta p(R|h,b)w_2(R,h) \geq w_1(\ell) + B \tag{ic_{oi}}$$

$$p(R|b)R - \big[p(\ell|b)w_1(\ell) + p(h|b)w_1(h) + p(R|h,b)w_2(R,h)\big] \geq I - A \tag{ir_{oi}}$$

$$w_1(\ell) = w_1(h) + \beta p(R|\ell,b) w_2(R,h)$$

$$w_2(R,\ell) = w_2(0,h) = w_2(0,\ell) = 0. \tag{rp}$$

This means that

$$w_1^{rp}(\ell) = \frac{p(R|\ell,b)}{p(\ell|b) + p(R|h,b) - p(R|\ell,b)} \tag{12}$$

$$w_2^{rp}(R,h) = \frac{1}{p(\ell|b) + p(R|h,b) - p(R|\ell,b)} \frac{B}{\beta}. \tag{13}$$

Again we can consider credit rationing problem from investor's rationality constraint;

$$A \geq A^{rp} \equiv \frac{p(\ell|b)p(R|\ell,b) + p(R|h,b)}{p(\ell|b)p(R|\ell,b) + p(R|h,b) - p(R|\ell,b)} B - \big[p(R|b)R - I\big]. \tag{14}$$

Proposition 2. *Compared to the transparent system, credit rationing problem will be relaxed by opaque system if and only if $A^s < A^{rp}$, that is,*

$$\frac{p(h|m)}{p(h|b)} > \frac{p(R|\ell,b)}{p(\ell|b)p(R|\ell,b) + p(R|h,b)}. \tag{15}$$

In both systems, investor can offer the contracts twice, (ex ante) initial contract and (ex post) renegotiation. She offers the initial contract with the renegotiation in mind. In transparent system, she can use her bargaining power fully. She knows that the renegotiation will be exercised about long-term contract, so the renegotiation-proof contract will be short-term contract. But, in the situations that we consider short-term contract is more costly for investor than long-term one. Therefore, she requires collateral to the manager more and the (efficient) project that the investor with less initial assets have will not rise up. On the other hand, in the opaque system, the investor cannot use her bargaining power fully because she cannot observe the signal. In renegotiation, the investor lose some bargaining power. This allows the possibility of long-term contract, and relax the credit rationing problem.

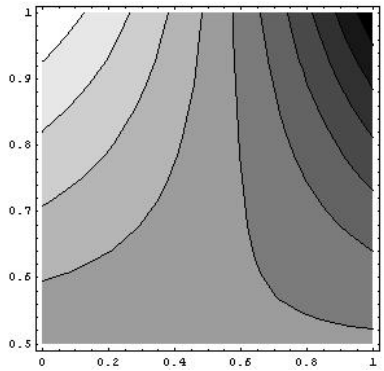

Figure 2:

Figure 2 shows the region that the opaque system is preferred one. Horizontal (vertical) axis represents probability of success p_s (precision of signal p). The opaque policy is desirable when the parameters locate in upper-left region of upward-sloping curve. That is, the probability of success is sufficiently low and the precision of the signal is high enough. Otherwise we can regard the precision of the signal as the technology of clinical test. Then, our opaque policy will suite for drug discovery industry.

6 Conclusion

This paper has examined the credit rationing problem where the investor can offer the new contract after the manager's effort. Even though the long-term contract is cheaper than the short-term one, the investor will be tempted by renegotiation at $t = 1$ and offer the early payment in transparent system. Then only short-term contract will be renegotiation-proof one that is costly for the investor. To cover this loss, the investor elevate the threshold of lending. That is, credit rationing problem will be worsened. If the manager is not required to show his information, there is the case that improve the credit rationing problem.

We assume that the investor offers both initial contract and renegotiation. If other economic agent offers each contract, the result may be changed. However we think that our example is one of the interesting cases. The other cases will be reserved for future research.

Appendix: The Formal Problem of Renegotiation with Transparent and Opaque Systems

Define $\{\tilde{w}_1(s), \tilde{w}_2(y,s)\}$ as any initial contract. Then, we can write the renegotiation problem under transparent system such that

$$\begin{aligned}
&\min_{w_1(\cdot),w_1(\cdot,\cdot)} E[w_1(s)+w_2(y,s)|e=b], \quad s\in\{\ell,h\} && (16)\\
&\text{s.t. } w_1(s)+\beta\big[p(R|s,b)w_2(R,s)+p(0|s,b)w_2(0,s)\big] \\
&\quad \geq \tilde{w}_1(s)+\beta\big[p(R|s,b)\tilde{w}_2(R,s)+p(0|s,b)\tilde{w}_2(0,s)\big] && (ir_{er})\\
&\quad w_1(s)+\big[p(R|s,b)w_2(R,s)+p(0|s,b)w_2(0,s)\big] \\
&\quad \geq \tilde{w}_1(s)+\big[p(R|s,b)\tilde{w}_2(R,s)+p(0|s,b)\tilde{w}_2(0,s)\big]. && (ir_{ir})
\end{aligned}$$

We can also write the renegotiation problem under opaque one such that

$$\begin{aligned}
&\min_{w_1(r),w_2(y,r)} E[w_1(r)+w_2(y,r)|e=b], \quad s\in\{\ell,h\} && (17)\\
&\text{s.t. } w_1(h)+\beta\big[p(R|h,b)w_2(R,h)+p(0|h,b)w_2(0,h)\big] \\
&\quad \geq \tilde{w}_1(\ell)+\beta\big[p(R|h,b)\tilde{w}_2(R,\ell)+p(0|h,b)\tilde{w}_2(0,\ell)\big] && (ic_{oh})\\
&\quad w_1(\ell)+\beta\big[p(R|\ell,b)w_2(R,\ell)+p(0|\ell,b)w_2(0,\ell)\big] \\
&\quad \geq \tilde{w}_1(h)+\beta\big[p(R|\ell,b)\tilde{w}_2(R,h)+p(0|\ell,b)\tilde{w}_2(0,h)\big] && (ic_{o\ell})\\
&\quad w_1(h)+\beta\big[p(R|h,b)w_2(R,h)+p(0|h,b)w_2(0,h)\big] \\
&\quad \geq \tilde{w}_1(h)+\beta\big[p(R|h,b)\tilde{w}_2(R,h)+p(0|h,b)\tilde{w}_2(0,h)\big] && (ir_{oh})\\
&\quad w_1(\ell)+\beta\big[p(R|\ell,b)w_2(R,\ell)+p(0|\ell,b)w_2(0,\ell)\big] \\
&\quad \geq \tilde{w}_1(\ell)+\beta\big[p(R|\ell,b)\tilde{w}_2(R,\ell)+p(0|\ell,b)\tilde{w}_2(0,\ell)\big]. && (ir_{o\ell})
\end{aligned}$$

The proofs of both problems are same as in Axelson and Baliga (2009).

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Financial Research Center（FSA Institute）
Financial Services Agency
Government of Japan

3-2-1 Kasumigaseki, Chiyoda-ku, Tokyo 100-8967, Japan

TEL：03-3506-6000（ext 3293）
FAX：03-3506-6716
URL：http://www.fsa.go.jp/frtc/english/index.html