

Earnings Manipulation and Risky Investment¹

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Abstract

This paper develops a formal model to study earnings manipulation. It analyzes the effects of real earnings, auditor quality and at-risk incentive on management's earnings manipulation decision. It shows that the management has the incentive to smooth corporate earnings even when the employment contract is linear. It also demonstrates that adding the ability to manipulate earnings to the principal-agent model drastically changes the management's attitude towards risk. The management will become risk seeking in the company's earnings when cumulative earnings management in previous periods is high, even if the management has a risk-averse utility function.

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1 Introduction

The waves of accounting scandals from Enron, WorldCom to Parmalat since 2001 have shocked stock markets and caused huge losses to investors around the world. Why does management manipulate earnings reports? How is earnings manipulation affected by company's performance, the auditor's quality and the at-risk incentive in the contract? And how does the ability to manipulate earnings affect the company's investment decisions, particularly the management's attitude towards risk? This paper constructs a formal model to study these issues.

The traditional theory of corporate governance (Jensen and Meckling (1976), Holmstrom (1979)) centers on the principal-agent model. The central idea is that because the shareholders cannot directly observe the effort by the management, executive compensation is linked to corporate earnings to give the management the incentive to exert efficient effort and align their interests with the shareholders'. However, in reality, the shareholders cannot observe real corporate earnings either. The executive compensation contract is not linked to the real earnings but instead to reported earnings in the financial statement prepared and released by the management. The management can exploit this information asymmetry and has the incentive and ability to manipulate reported information. Although there are mechanisms such as auditors and boards of directors in the corporate governance to prevent it from happening, the auditors and board of directors have their own agency problems and may not exert enough effort to minimize the problem and guard the shareholders' interests. Also, as argued by Tirole (1986), directors and auditors may collude with the management to present false financial reports. The accounting scandals cited above clearly indicates that 'these mechanisms are far from adequate in preventing earnings manipula-

tion.

In this paper, I formally model the earnings manipulation process. I assume that the probability earnings manipulation being discovered increases with cumulative historical accounting overstatement. Under quite general conditions, I get several interesting results.

Firstly, management has the incentive to move corporate earnings from periods of good performance to periods of bad performance. Because the model assumes the executive compensation contract is linear, this suggests that the existence of earnings smoothing does not depend on the non-linearity of the contract.

Secondly, we identify two effects of an at-risk amount on earnings manipulation: "incentive effect" and "income effect". "Incentive effect" means that higher at-risk amount implies higher return to earnings overstatement, and hence more earnings manipulation. The sign of the "income effect" is ambiguous. When reported earnings are positive, higher at-risk amount means higher income for the management. The management has more to lose if caught for fraud. Unless management are extremely risk seeking, this implies they will engage in less earnings manipulation. If the reported earnings are negative, then vice versa, the income effect means the higher the at-risk amount the higher earnings overstatement. Therefore, the relationship between at-risk amount and earnings manipulation is ambiguous. However, in the special case that the management is risk-neutral, the incentive effect always dominates the income effect. High-power incentive contract will lead to higher overstatement. This suggests that such contracts usually in the form of stock options have some serious side effects.

Most importantly, this paper shows that the ability to manipulate earnings reports can drastically change the management's attitude towards risk.

Even if management is very risk-averse in its own income, when the cumulative earnings overstatement is high, the management will turn risk seeking with respect to corporate earnings. As argued in the paper, because the probability of an accounting scandal is bounded between 0 and 1, it is reasonable to assume that asymptotically this probability is a concave function of the cumulative accounting overstatement. Therefore the probability of the accounting fraud not being discovered is a convex function asymptotically. Under quite general conditions, this convexity will dominate the risk-aversion of the utility function. The management will prefer risky projects and may pay huge risk premiums for very risky project with very low expected returns. The shareholders may be inflicted with huge losses by such excessively risk-seeking behavior.

Almost all companies involved in accounting scandals since 2001 made some apparently irrational decisions just before the scandals became public. In the last 3 years of its existence, Enron invested \$1 billion in information technology for its trading activity which is almost worthless now. WorldCom and Global Crossing gambled by borrowing billions of dollars to lay fiber-optic cable and selling the signal-carrying capacity to corporations. Palamat engaged in complicated financial derivatives deals that resulted in huge losses. Lev (2003) identifies these investment decisions as one of the main social costs of these accounting scandals.

It is not easy to explain these investment decisions using traditional principal-agent models. With very high previous accounting discrepancy, the executives in these companies face a high probability of accounting scandals. They have very strong incentives to exert maximum effort and try to make up past earnings overstatement. We would expect these companies to have a better than average performance. And because almost all of these

companies were very successful in the past, these investment decisions cannot be entirely attributed to management incompetence. More naturally, these investment decisions should be regarded as the results of risk-seeking behavior by the management.

Literature Review

The literature on general corporate governance is directly relevant to this paper. For surveys on general corporate governance literature, see Shleifer and Vishny (1997) and Denis (2001). Murphy (1997) provides a comprehensive survey on executive compensation.

There is a considerable empirical literature on earnings manipulation. It studies the effects of accruals and various kinds of accounting loopholes on earnings manipulation. The seminal paper in this area is Healy (1985) and Healy and Wahlen (1999) provides a comprehensive survey.

There are few theoretical models of earnings manipulation. Healy (1985) shows how non-linear contracts especially bonus plans can induce the management to smooth earnings. Stein (1989) shows that management has the incentive to inflate current earnings and forsake good investments to boost stock prices. Bergstresser and Philippon (2003) show how stock options gives the management the incentive to overstate earnings.

On management's attitude towards risk and its effect on investment decision, Garen (1994) argues that when the shareholders' investment is well-diversified, shareholders are approximately risk-neutral. Because the management has its human capital tied to the company and therefore is risk-averse, the management will make a more conservative investment choice than the shareholders prefer. There is also a strand of literature concerning how the management's attitude towards risk can be affected by different

factors. Hirshleifer and Thakor (1992) and Hermalin (1993) show how career concern can make the management excessively risk-averse. Palomino and Prat (2003) shows that for money managers a bonus contract can cause either excessive or insufficient risk taking behavior.

The setup of the model consists of 3 periods. In period 1, with the knowledge of previous accounting discrepancy, the management chooses a project. In period 2, the outcome of the project materialises. The management observes the real earnings and decides reported earnings. In period 3, if the accounting fraud is discovered, management goes to prison. Otherwise, management receives compensation linearly linked to reported earnings. The probability of such discovery increases with respect to the cumulative accounting discrepancy.

2 Setting of the Model

In a principal-agent model, the shareholders hire management to run the company and make investment decisions. The employment contract is exogenous to this model and we assume it is a linearly increasing function of the company's reported earnings denoted by x . Real earnings are denoted by y , which is only observable to the management but cannot be observed by the shareholders. We assume the payment contract is $bx + s$, where $0 < b < 1$, where b denotes at-risk incentive of the contract and s the basic salary. This contract can be either a performance plan explicitly linked to reported earnings, or in the form of stock options. We denote the cumulative earnings discrepancy carried forward from previous earnings report as q . The reported earnings discrepancy in the current period is $x - y$, hence the cumulative earnings discrepancy at the end of the period is $x - y + q$.

Although the shareholders cannot observe y , we assume there is proba-

bility $P(x - y + q) = 1 - e^{-af(x-y+q)}$ that the accounting fraud will be discovered. This will either be due to the monitoring of auditors and boards of directors, or the company simply running out of cash. The parameter $a > 0$ denotes the efficiency of the auditor's work. We assume $f(0) = 0$, hence $P(0) = 0$, which means if the cumulative earnings discrepancy is zero, the probability of an accounting scandal is zero. We also assume $f(+\infty) = +\infty$, so $P(+\infty) = 1$, as the cumulative earnings discrepancy tends to positive infinity, the probability that it will be discovered is 1. $f'(t) > 0$, if $t > 0$, $f'(t) < 0$ if $t < 0$. Therefore we assume $f'(0) = 0$ to make $f(\cdot)$ differentiable at 0. Asymptotically, we assume $f'(+\infty) = \infty$. Also, the probability P satisfies the monotone hazard-rate property, which is equivalent to $f'' > 0$. Finally f'' is continuous. Although we impose many restrictions on P , this specification is still quite general. For example the Weibull distribution $1 - P = e^{-a(x-y+q)^{2n}}$, $n \geq 1$ satisfies all the conditions.

If accounting fraud is discovered, the management will go to prison and its utility level is 0. If no accounting fraud is discovered, the management will get payment $bx + s$ and utility $e^{w(bx+s)}$. The function $w(\cdot)$ is three-times differentiable and we assume $w' > 0$, which means utility increases with respect to payment, and $w'' < 0$. Because the management is risk-neutral when $w'' = -(w')^2$, risk-averse when $w'' < -(w')^2$ and risk seeking when $w'' > -(w')^2$, the assumption $w'' < 0$ means that the utility function of the management can be risk-averse, risk-neutral or moderately risk seeking. Furthermore, we assume $w'(-\infty) = +\infty$, $w'(+\infty) = 0$.

The main job of the management is to choose between a risky project Y and a safe project C . A risky project Y is characterized by a cumulative distribution function $F(y)$, which is the probability that the realized earnings is less than or equal to y . The support of y is $[\underline{y}, \bar{y}]$. Because the preference

of the management over different projects may not coincide with that of the shareholders, potentially there is an agency problem.

Although management effort level does not enter the model directly, the assumption $b > 0$ implicitly assumes that management needs to spend some effort acquiring and analyzing the information of different projects, which ensures that optimal b cannot be zero. Because the main concern of the paper is not on the form of the optimal contract, but on earnings manipulation decision and how it can affect project choice, we choose not to model management effort level explicitly.

We place the order of events in this model into three periods. In period 1, with the knowledge of q , the management chooses the investment project. In period 2 the project outcome materializes, management observes y , and reports x to the shareholders. In period 3, with probability $P(x-y+q) = 1 - e^{-af(x-y+q)}$, the earnings manipulation will be discovered and management gets utility 0. With probability $1 - P(x-y+q) = e^{-af(x-y+q)}$, the earnings manipulation will not be discovered. The management will receive payment $bx + s$, and get utility $e^{w(bx+s)}$.

3 Earnings Manipulation Decision

In this section, we concentrate on period 2 and discuss what the management's choice of x will be when it observes y . To do this, we consider the characteristics of the expected utility of management:

$$U = e^{w(bx+s)} e^{-af(x-y+q)} \quad (1)$$

Differentiating it with respect to x , we get the first-order condition:

$$bw'(bx+s) - af'(x-y+q) = 0 \quad (2)$$

Because we assume both w' and f' are continuous functions, the solution to (2) always exists. And because $w'' < 0$, $f'' > 0$, this solution is unique. Therefore (2) defines a one-to-one relationship between x and y .

The second-order condition is:

$$\begin{aligned} \frac{d^2U}{dx^2} &= [bw'(bx+s) - af'(x-y+q)]^2 e^{w(bx+s)-af(x-y+q)} \\ &\quad + [b^2w''(bx+s) - af''(x-y+q)] e^{w(bx+s)-af(x-y+q)} \\ &= [b^2w''(bx+s) - af''(x-y+q)] e^{w(bx+s)-af(x-y+q)} \\ &< 0 \end{aligned}$$

Hence, (2) defines the utility maximizing point.

Lemma 1 $x - y + q > 0$, and $x > y$ when $q = 0$.

Proof By the first-order condition, $af'(x-y+q) = bw'(bx+s) > 0$. Because f' is a monotone increasing function and $f'(0) = 0$, $x - y + q > 0$. ■

This lemma shows that the cumulative earnings manipulation is always positive. It is interesting that at $b = 0$, $x - y + q = 0$. Therefore, earnings

manipulation is the direct result of positive at-risk incentive and imperfect monitoring mechanisms. When the previous cumulative earnings discrepancy is zero, the management will always overstate the current earnings. But when q is positive, it is possible for x to be less than y . How the size and sign of earnings manipulation is affected by the values of y and q is described in the next four lemmas.

Lemma 2 $0 < \frac{dx}{dy} < 1$

Proof Differentiate (2) with respect to y ,

$$b^2 w''(bx + s) \frac{dx}{dy} - a f''(x - y + q) \left(\frac{dx}{dy} - 1 \right) = 0$$

Arrange it:

$$\frac{dx}{dy} = \frac{-a f''(x - y + q)}{b^2 w''(bx + s) - a f''(x - y + q)}$$

Hence, $0 < \frac{dx}{dy} < 1$. ■

This lemma shows that reported earnings increase with real earnings, but do so at a slower rate. Rearranging the the expression of $\frac{dx}{dy}$, we get $\frac{d(x-y)}{dy} = \frac{d(x-y+q)}{dy} = \frac{dx}{dy} - 1 < 0$. Thus the amount of current earnings manipulation decreases with respect to y . The intuition behind this is that the higher the real earnings, the more the management have to lose if the accounting fraud is found out. Unless the management's utility function is extremely risk seeking (which is ruled out by the assumption $w'' < 0$), it will become less inclined to take the risk. Empirically this lemma suggests we should expect less earnings manipulation from companies that perform well: and fraud is much more likely to occur in companies that are in deep trouble. Rosner (2003) finds that firms facing bankruptcy are more likely

to engage in fraudulent financial reporting, which is consistent with this lemma's prediction.

Lemma 3 $-1 < \frac{dx}{dq} < 0$

Proof Differentiate (2) with respect to q ,

$$b^2 w''(bx + s) \frac{dx}{dq} - a f''(x - y + q) \left(\frac{dx}{dq} + 1 \right) = 0$$

Arrange it:

$$\frac{dx}{dq} = \frac{a f''(x - y + q)}{b^2 w''(bx + s) - a f''(x - y + q)}$$

Hence, $-1 < \frac{dx}{dq} < 0$. ■

The current earnings manipulation $x - y$ is low if the cumulative earnings discrepancy from previous periods is high. Later, Lemma 4 will show that $x - y$ turns negative as q increases. The management has the incentive to make up previous overstatement and keep it from exploding. However, $\frac{d(x-y+q)}{dq} = \frac{dx}{dq} + 1 > 0$, which means high previous cumulative earnings overstatement still implies high current cumulative earnings overstatement.

The next two Lemmas describe the asymptotic behavior of x and $x - y + q$, when y or q tends to infinity. They are of some interest in themselves, but are important to prove the theorems that follows.

Lemma 4 *Let y be fixed, as $q \rightarrow +\infty$, $x \rightarrow -\infty$ and $x - y + q \rightarrow +\infty$.*

Proof We prove this lemma by contradiction. By Lemma 3, we know as $q \rightarrow +\infty$, x will decrease, and $x - y + q$ will increase. If x does not tend to negative infinity, it is bounded from below. This means $x - y + q$ and $a f'(x - y + q)$

will tend to infinity and since $w'' < 0$, $bw'(bx + s)$ is bounded from above. However, by (2), $bw'(bx + s) = af'(x - y + q)$, this is a contradiction. So x is not bounded from below, it will tend to negative infinity as $q \rightarrow +\infty$.

Because when $x \rightarrow -\infty$, $bw'(bx + s) \rightarrow +\infty$. By (2), $af'(x - y + q) \rightarrow +\infty$, hence $x - y + q \rightarrow +\infty$. ■

Lemma 5 *Let q be fixed, as $y \rightarrow +\infty$, $x \rightarrow +\infty$ and $x - y + q \rightarrow 0$. As $y \rightarrow -\infty$, $x \rightarrow -\infty$ and $x - y + q \rightarrow +\infty$.*

Proof This proof is very similar to that of Lemma 4. We prove it by contradiction. By Lemma 2, we know as $y \rightarrow +\infty$, x will increase, and $x - y + q$ will decrease. If x does not tend to infinity, it is bounded from above. This means $x - y + q$ and $af'(x - y + q)$ will tend to negative infinity and $bw'(bx + s)$ is bounded from below. However, by (2), $bw'(bx + s) = af'(x - y + q)$, this is a contradiction. So x is not bounded from above, it will tend to infinity as $y \rightarrow +\infty$.

Because when $x \rightarrow +\infty$, $bw'(bx + s) \rightarrow 0$. By (2), $af'(x - y + q) \rightarrow 0$, hence $x - y + q \rightarrow 0$.

When $y \rightarrow -\infty$, the proof is exactly the same and is omitted. ■

Lemmas 2-5 mean that $x - y$ is negative when y and q are large but positive when y and q are small. Therefore management will understate earnings when the company's real earnings and past overstatement are high, and overstate earnings when the real earnings and past overstatement are low. In other words, the management has the incentive to move earnings from good periods to bad periods and engage in earnings smoothing. Previous studies on earnings smoothing (such as Healy (1985) and Oyer(1998)) attribute its cause to the non-linearity of the executive contract. However, these 4 lemmas show that even with linear contracts, management still has

the incentive to smooth earnings.

Next we discuss how earnings manipulation is affected by other parameters of the model, such as the efficiency of the auditors and the at-risk incentive of the contract.

Theorem 1 $\frac{dx}{da} < 0$

Proof Differentiate (2) with respect to a ,

$$b^2w''(bx+s)\frac{dx}{da} - f'(x-y+q) - af''(x-y+q)\frac{dx}{da} = 0$$

Because $x - y + q > 0$ by Lemma 1, we get

$$\frac{dx}{da} = \frac{f'(x-y+q)}{b^2w''(bx+s) - af''(x-y+q)} < 0$$

■

Here a represents the efficiency of the work of the auditors and other monitoring mechanisms. A large a means it is hard for the management to manipulate earnings without being detected. Theorem 1 shows it leads to a lower level of earnings manipulation.

Theorem 2 $\frac{dx}{ds} < 0$

Proof Differentiate (2) with respect to s ,

$$bw''(bx+s) + b^2w''(bx+s)\frac{dx}{ds} - af''(x-y+q)\frac{dx}{ds} = 0$$

and arrange it,

$$\frac{dx}{ds} = \frac{bw''(bx+s)}{af''(x-y+q) - b^2w''(bx+s)} < 0$$

■

When the base salary increases, management risks more in manipulating earnings, which leads to less earnings manipulation by the management.

The relationship between x , the reported earnings and b , the incentive provided in the contract is more complicated. Differentiating (2) with respect to b , we get

$$b^2 w''(bx + s) \frac{dx}{db} + w'(bx + s) + x w''(bx + s) - f''(x - y + q) \frac{dx}{db} = 0$$

Upon rearrangement, we get Theorem 3,

Theorem 3

$$\frac{dx}{db} = \frac{-w'(bx + s)}{b^2 w''(bx + s) - a f''(x - y + q)} + \frac{-bx w''(bx + s)}{b^2 w''(bx + s) - a f''(x - y + q)} \quad (3)$$

The sign of $\frac{dx}{db}$ is ambiguous. The first term of (3), the "incentive effect" is always positive. It means the greater the at-risk incentive in the contract, the greater the return to earnings manipulation, and the greater is the earnings overstatement incentive. The second term, the "income effect", depends on the sign of x . When x is positive, higher b means higher payment to the management and less earnings manipulation. If x is negative, then vice versa, the income effect is positive, and we get Corollary 1.

Corollary 1 $\frac{dx}{db} > 0$, if $x < 0$.

This corollary means that for companies making large losses, an increase in at-risk incentive can lead to greater earnings manipulation. However, the value of this corollary is limited, because the condition here is negative reported earnings instead of negative real earnings. In reality, Enron, WorldCom claimed high reported earnings even while they made huge losses.

The next two corollaries are more general.

Corollary 2 *At $b = 0$, $\frac{dx}{db} > 0$.*

Corollary 2 means that any movement from no at-risk incentive to positive at-risk incentive will lead to management earnings manipulation. So $b > 0$ is the root cause of $x - y + q > 0$.

Corollary 3 *If $w(bx + s) = \ln(\alpha(bx + s) + \beta)$, $\alpha > 0$, $\alpha(bx + s) + \beta > 0$ for all feasible x and $\alpha s + \beta > 0$, then $\frac{dx}{db} > 0$.*

Proof Substituting $w(bx + s) = \ln(\alpha(bx + s) + \beta)$ into (3), we get

$$\begin{aligned} \frac{dx}{db} &= \left(\frac{-\alpha}{\alpha(bx + s) + \beta} + \frac{\alpha^2 bx}{[\alpha(bx + s) + \beta]^2} \right) \frac{1}{b^2 w''(bx + s) - a f''(x - y + q)} \\ &= \frac{-\alpha(\alpha s + \beta)}{[\alpha(bx + s) + \beta]^2 (b^2 w''(bx + s) - a f''(x - y + q))} \\ &> 0 \end{aligned}$$

■

If the management is risk-neutral, $w(bx + s)$ will take the form $\ln(\alpha(bx + s) + \beta)$, and $e^{w(bx+s)} = \alpha(bx + s) + \beta$. The condition $\alpha(bx + s) + \beta > 0$ is to ensure $w(bx + s)$ is well defined and the management's utility is always higher than zero (the utility level when the accounting fraud is discovered). Therefore, this corollary means when the management is risk-neutral, the incentive effect is always greater than the income effect of an increase in variable payment. An increase in at-risk incentive b will always lead to greater earnings manipulation.

In conclusion, the preceding discussion shows that there are serious side-effects in giving management high-powered incentive contracts. The return

from earnings manipulation will increase and lead to greater earnings overstatement. The popularity of high-powered incentive contracts in the form of stock options in late 1990s may be one of the most important causes of the accounting scandals surfaced since 2000. Because our model does not take into account the information asymmetry in the management's action and ability, these theorems do not mean high-powered incentive contracts should be rejected. But it does suggest caution in adopting them.

Investment Decision

In this section, we turn from period 2 to period 1 and discuss how the ability to manipulate earnings can affect the management's investment choice.

If there is no possibility of earnings manipulation as in standard principal-agent models, the utility of the management is $u = e^{w(by+s)}$. If $w'' + (w')^2 < 0$, that is to say the management is risk-averse as usually assumed, it will prefer projects with high return and low risk. However, as we will show below, if management can manipulate earnings, even though management's preference over expected returns does not change, their attitude towards risk changes drastically.

Theorem 4 *The management's utility increases with respect to real earnings, that is to say, $\frac{dU}{dy} > 0$*

Proof By the envelope theorem,

$$\frac{dU}{dy} = af'(x - y + q)e^{w(bx+s)-af(x-y+q)}$$

And by Lemma 1, $\frac{dU}{dy} > 0$. ■

Corollary 4 *If project Y_1 with cdf $F(\cdot)$ first-order stochastically dominates project Y_2 with cdf $G(\cdot)$, then:*

$$\int U(y)dF(y) \geq \int U(y)dG(y) \quad (4)$$

That is to say, the management will prefer project Y_1 to project Y_2 .

Proof Theorem 4 means $U(y)$ is an increasing function in y . From the definition of first-order stochastic dominance, we get (4). ■

Theorem 4 and Corollary 4 indicates the management's attitude with respect to expected returns does not change as a consequence of their ability to manipulate earnings. They still prefer higher return projects to lower return ones, and have no conflict with the interests of shareholders in this respect.

We measure the level of the management's risk attitude using Arrow-Pratt coefficient of absolute risk aversion (Arrow (1970), Pratt(1964)). At y it is defined as:

$$r_A(y) = -\frac{U''(y)}{U'(y)}$$

The management is locally risk-neutral at y if $r_A(y) = 0$, locally risk-averse if $r_A(y) > 0$, locally risk-seeking if $r_A(y) < 0$. The certainty equivalent of project Y with cdf $F(\cdot)$, denoted $c(Y, u)$, is defined as the amount of money for which the individual is indifferent between project Y and the certain amount $c(Y, u)$, where u is the utility function; that is,

$$u(c(Y, u)) = \int_{\underline{y}}^{\bar{y}} u(x)dF(x)$$

To complete the analysis, we need Pratt's Theorem to study how changes

in $r_A(y)$ will affect project choice.

Lemma 6 *Given two Bernoulli utility function $u_1(\cdot)$ and $u_2(\cdot)$,*

1. $r_A(y, u_2) > r_A(y, u_1)$, for all y .

2. $c(F, u_2) < c(F, u_1)$ for any $F(\cdot)$

are equivalent.

Proof See Mas-Colell, Whinston and Green (1995) p.191. and the Solution Manual by Hara, Segal and Tadelis (1996) ■

Given that the management can manipulate earnings reports, because

$$U'' = (-af''(x-y+q) \frac{b^2w''(bx+s)}{af''(x-y+q) - b^2w''(bx+s)} + [af'(x-y+q)]^2)e^{w(bx+s)-af(x-y+q)}$$

absolute risk aversion takes the form:

$$r_A(y) = -af'(x-y+q) - \frac{f''(x-y+q)}{f'(x-y+q)} \frac{b^2w''(bx+s)}{af''(x-y+q) - b^2w''(bx+s)} \quad (5)$$

The first term of $r_A(y)$ is negative, the second term is positive, so the sign of $r_A(y)$ is undetermined. When $x-y+q$ tends to infinity, $f'(x-y+q)$ tends to infinity. Because $\frac{b^2w''(bx+s)}{af''(x-y+q) - b^2w''(bx+s)}$ is bounded between 0 and 1, if $f''(x-y+q)$ does not increase too fast, the first term of (5) will dominate the second term. $r_A(y)$ becomes negative. The following lemma formalize the above discussion.

Assumption 1 $\lim_{t \rightarrow +\infty} \frac{f''(t)}{a[f'(t)]^2} < 1$.

Let $x-y+q = t$, then the probability of an accounting scandal is $P(t) = 1 - e^{-af(t)}$ and $\frac{d^2P}{dt^2} = (af''(t) - a^2[f'(t)]^2)e^{-af(t)}$. Therefore, Assumption 1 means $P(t)$ is concave asymptotically. Since $P(t)$ is bounded

between 0 and 1, and increases in t , it cannot be asymptotically convex or linear. Even in cases where Assumption 1 is not satisfied for all the points of t , asymptotically P is still concave for most of the points. Therefore, Assumption 1 is at least a reasonable approximation.

Since P is asymptotically concave, $1 - P$ is asymptotically convex. The utility function of the management is the product of a concave function and a convex function. Because x is a function of y from an optimization problem, Lemma 7 shows that the convexity of $1 - P$ will dominate.

Lemma 7 *Under Assumption 1, for every y , there always exists q_1^* , such that when $q > q_1^*$, $r_A(y) < 0$.*

Proof By Lemma 3 and 4 we know that $x - y + q$ is continuous and increasing in q , and has the range $(0, +\infty)$. Therefore, $r_A(y)$ is continuous in q . As $q \rightarrow +\infty$, $x - y + q \rightarrow +\infty$, $f'(x - y + q) \rightarrow +\infty$.

$$\text{Because } 0 < \frac{b^2 w''(bx^* + s)}{af''(x^* - y^* + q) - b^2 w''(bx^* + s)} < 1$$

$$\lim_{q \rightarrow +\infty} r_A(y) < \lim_{t \rightarrow +\infty} \left(-af'(t) + \frac{f''(t)}{f'(t)} \right) = \lim_{t \rightarrow +\infty} -af'(t) \left(1 - \frac{f''(t)}{a[f'(t)]^2} \right) < 0$$

Therefore, there exists q_1^* such that when $q \geq q_1^*$, $r_A(y) < 0$ ■

We can regard Lemma 7 as a generalization of the "gambling for resurrection" (Romer and Weingast (1991)) phenomenon. If the probability of an accounting scandal is 1 after some threshold, as in the "gambling for resurrection" situation, P is concave at the threshold point. Therefore, the argument that the management was risk-seeking for insured thrift industry in 1980s really hinges on the concavity of P at the threshold point and can be viewed as a special case of Lemma 7.

When q is high enough, management can be locally risk-seeking at any

value of y . Because we assume the support of a project's return is bounded, when q is sufficiently high, the management will become risk-seeking at all possible values of y .

Theorem 5 *Under Assumption 1, for every risky project Y with cdf $F(\cdot)$, there exists q_2^* such that when $q > q_2^*$, $c(Y, u(q)) > E(Y)$. When facing a choice between a safe project C with return $c(Y, u(q)) - \epsilon$ and a risky project Y , the management will prefer Y , for any positive number ϵ .*

Proof Let $q_2^* = \max(q_1^*(y) | y \in [\underline{y}, \bar{y}])$, where $q_1^*(y)$ is defined in the Lemma 7. Then if $q \geq q_2^*$, $r_A(y) < 0$ for $y \in [\underline{y}, \bar{y}]$. Let $u_1(\cdot) = u(q)$, $u_2(x) = x$. Since the utility function of $u_2(x)$ is risk-neutral, $r_A(u_2) = 0$, $c(Y, u_2) = E(Y)$. Therefore, by Pratt's Theorem, $c(Y, u(q)) > E(Y)$ if $q > q_2^*$.

By the definition of $c(Y, u(q))$, the management will prefer Y over C .

■

Because ϵ can take very small values, Theorem 5 means that when q is very high, it is possible for the management to choose a risky project over a safe project even if the risky project's expected return is less than the safe return. Even if the shareholders' investments are well diversified and shareholders are risk-neutral, the management's risk seeking behavior is still undesirable. If the shareholders have a substantial amount of their wealth invested in the company and are risk-averse, the risk seeking behavior is extremely detrimental to their interests.

Next we study how the management's risk-seeking behaviour will change as previous accounting discrepancy increases, that is to say how $r_A(y)$ will behave as q tends to infinity. Intuitively, the behavior of $r_A(y)$ depends on the concavity of P and the curvature of U . We need stronger conditions on them to study whether $r_A(y)$ will increase or decrease asymptotically.

Assumption 2 f''' exists and is continuous.

$$\lim_{t \rightarrow +\infty} \frac{f'''(t)}{f'(t)} \leq 0$$

Because the curvature of $P(t)$ is $d[\frac{d^2P/dt^2}{dP/dt}]/dt = -af''(t) - [\frac{f''}{f'}]^2 + \frac{f'''(t)}{f'(t)}$, Assumption 2 is a sufficient condition to ensure the concavity of $P(x-y+q)$ increases as $x-y+q$ increases asymptotically. Intuitively this means as q increases, $P(x-y+q)$ becomes more and more concave, and the management becomes more and more risk-seeking.

Assumption 3 w''' exists and is continuous.

$$\lim_{t \rightarrow -\infty} \frac{w'''(t)}{w'(t)} < 2(\frac{w''}{w'})^2$$

The absolute risk-aversion for the utility function $e^{w(\cdot)}$ is $-w' - \frac{w''}{w'}$. Differentiating it, we get $-\frac{w'''}{w'} - w'' + (\frac{w''}{w'})^2$, as the risk-aversion of $e^{w(bx+s)}$ does not increase as x decreases, if $\frac{w'''}{w'} \leq -w'' + (\frac{w''}{w'})^2$. When the management is risk-averse, $-\frac{w''}{w'} < 1$, and we have $\frac{w'''}{w'} < 2(\frac{w''}{w'})^2$. Therefore, Assumption 3 means risk-aversion of management with respect to income does not increase as the income level falls.

Lemma 8 Under Assumption 1-3, For every y , there exists q_3^* such that when $q > q_3^*$, $\frac{dr_A(y)}{dq} < 0$.

Proof If $\frac{w'''}{w'} < 2(\frac{w''}{w'})^2$ and $\frac{f''}{a[f']^2} < 1$.

$$\begin{aligned}
\frac{dr_A(y)}{dq} &= \left(-af'' - \frac{[f'']^2 b^2 w''}{[f']^2 (b^2 w'' - af'')} + \frac{f'''}{f'} \left[\frac{b^2 w''}{b^2 w'' - af''}\right]^2\right) \left(\frac{dx}{dq} + 1\right) \\
&\quad - \frac{ab^3 w'''}{f'} \left[\frac{f''}{b^2 w'' - af''}\right]^2 \frac{dx}{dq} \\
&= \left(-af'' - \frac{[f'']^2 b^2 w''}{[f']^2 (b^2 w'' - af'')} + \frac{f'''}{f'} \left[\frac{b^2 w''}{b^2 w'' - af''}\right]^2\right) \frac{b^2 w''}{b^2 w'' - af''} \\
&\quad - \frac{(ab)^2 w'''}{w'} \left[\frac{f''}{b^2 w'' - af''}\right]^2 \frac{af''}{b^2 w'' - af''} \\
&< \left(-af'' - \frac{[f'']^2 b^2 w''}{[f']^2 (b^2 w'' - af'')} + \frac{f'''}{f'} \left[\frac{b^2 w''}{b^2 w'' - af''}\right]^2\right) \frac{b^2 w''}{b^2 w'' - af''} \\
&\quad - \left[\frac{f''}{f'}\right]^2 \left[\frac{b^2 w''}{b^2 w'' - af''}\right]^2 \frac{2af''}{b^2 w'' - af''} \\
&= -af'' \frac{b^2 w''}{b^2 w'' - af''} - \left[\frac{f''}{f'}\right]^2 \frac{b^2 w'' + af''}{b^2 w'' - af''} \left[\frac{b^2 w''}{b^2 w'' - af''}\right]^2 + \frac{f'''}{f'} \left[\frac{b^2 w''}{b^2 w'' - af''}\right]^3 \\
&< -af'' \frac{b^2 w''}{b^2 w'' - af''} - af'' \frac{af''}{b^2 w'' - af''} \frac{b^2 w''}{b^2 w'' - af''} + \frac{f'''}{f'} \left[\frac{b^2 w''}{b^2 w'' - af''}\right]^3 \\
&< -af'' \left[\frac{b^2 w''}{b^2 w'' - af''}\right]^2 + \frac{f'''}{f'} \left[\frac{b^2 w''}{b^2 w'' - af''}\right]^3 \\
&< \frac{f'''}{f'} \left[\frac{b^2 w''}{b^2 w'' - af''}\right]^3
\end{aligned}$$

By Lemma 2 and 4, as $q \rightarrow +\infty$, $x \rightarrow -\infty$, $x - y + q \rightarrow +\infty$, $af'(x - y + q) \rightarrow +\infty$. By Assumption 1-3,

$$\lim_{q \rightarrow +\infty} \frac{dr_A(y)}{dq} < \lim_{t \rightarrow +\infty} \frac{f'''}{f'} \left[\frac{b^2 w''}{b^2 w'' - af''}\right]^3 \leq 0$$

Therefore, there exists q_3^* such that when $q > q_3^*$, $\frac{dr_A(y)}{dq} < 0$. ■

Theorem 6 Under Assumption 1-3, for every project Y , there always exists q_4^* , such that when $q_A > q_B > q_4^*$, $c(Y, u(q_A)) > c(Y, u(q_B))$.

If the management has to choose between a risky project Y and a safe project C , and the return of C is $\frac{c(Y, u(q_A)) + c(Y, u(q_B))}{2}$, it will prefer Y when $q = q_A$ and the safe project, when $q = q_B$.

Proof Let $q_4^* = \max(q_3^*(y) | y \in [\underline{y}, \bar{y}])$, where $q_3^*(y)$ is the function defined in the proof of Lemma 8. Then if $q_A > q_B > q_4^*$, $r_A(y, q_A) < r_A(y, q_B)$ for all $y \in [\underline{y}, \bar{y}]$. By Pratt's Theorem, $c(Y, u(q_A)) > c(Y, u(q_B))$.

Because $c(Y, u(q_B)) < \frac{c(Y, u(q_A)) + c(Y, u(q_B))}{2} < c(Y, u(q_A))$, by definition, the management will prefer the safe project if $q = q_B$ and the risky project if $q = q_A$. ■

Theorem 6 means when q is large, as it increases, the management becomes more and more inclined to choose the risky project even if its expected return is well below the return of the safe project. The agency problem of risk-seeking behavior becomes worse and worse. In real cases, Enron and WorldCom made highly risky investments after they had greatly overstated their earnings in late 1990s, even if the prospects of these projects were very dubious. These investments caused colossal losses for the shareholders in these companies.

Finally, we discuss the effects of auditor efficiency a on management's risk taking behavior. On the one hand, an increase in a will reduce x . By Lemma 8, this means the utility function $e^{w(bx+s)-af(x-y+q)}$ is less convex and the management becomes less risk-seeking. On the other hand, because the curvature of P is $d[\frac{d^2P/dt^2}{dP/dt}]/dt = \lim_{t \rightarrow +\infty} -af'''(t) - [\frac{f''}{f'}]^2 + \frac{f'''(t)}{f'(t)}$, an increase in a will increase the concavity of P . Therefore, the effect of a on $r_A(y)$ is ambiguous. Theorem 7 shows that as long as the curvature of P does not change too fast (for example, when $1 - P$ follows a Weibull distribution), the second effect dominates and an increase in a will lead to an increase in risk-seeking behavior.

Assumption 4 $\lim_{t \rightarrow +\infty} \frac{f''(t)}{f'(t)} = 0$,

and $\lim_{t \rightarrow +\infty} \frac{f'''(t)}{f'(t)} \geq 0$

Theorem 7 Under Assumption 3 and 4, let y and q be fixed, there exists q_5^* such that when $q \geq q_5^*$, $\frac{dr_A(y)}{da} < 0$.

Proof

$$\begin{aligned} \frac{dr_A(q)}{da} &= -f' + \frac{(f'')^2(b^2w'')}{f'(af'' - b^2w'')^2} + (-af'' + \frac{[f'']^2b^2w''}{[f']^2(af'' - b^2w'' - af'')}) + \frac{f'''}{f'} \left[\frac{b^2w''}{b^2w'' - af''} \right]^2 \frac{dx}{da} \\ &\quad - \frac{(ab)^2w'''}{w'} \left[\frac{f''}{b^2w'' - af''} \right]^2 \frac{dx}{da} \end{aligned}$$

By Assumption 3 and 4, and because $\frac{dx}{da} < 0$,

$$\begin{aligned} \lim_{q \rightarrow +\infty} \frac{dr_A(q)}{da} &\leq \lim_{q \rightarrow +\infty} -f' - af'' \frac{dx}{da} - 2 \frac{(abw'')^2}{w'^2} \left[\frac{f''}{b^2w'' - af''} \right]^2 \frac{dx}{da} \\ &= \lim_{q \rightarrow +\infty} -f' - af'' \frac{dx}{da} - 2 \left[\frac{f''}{f'} \right]^2 \left[\frac{b^2w''}{b^2w'' - af''} \right]^2 \frac{dx}{da} \\ &\leq \lim_{q \rightarrow +\infty} -f' \left(1 + \frac{af''}{b^2w'' - af''} \right) \\ &= \lim_{q \rightarrow +\infty} - \frac{b^2w''f'}{b^2w'' - af''} \\ &< 0 \end{aligned}$$

Therefore there exists q_5^* , when $q > q_5^*$, $\frac{dr_A(q)}{da} < 0$. ■

Theorem 7 shows when q is large, it is possible that an increase in auditor efficiency can exacerbate the agency problem of the management's risk-seeking behavior. Better auditing system may induce the management to become more aggressive in his project choice. Paradoxically, the effort to reduce earnings manipulation may mean an increase in its damage.

4 Conclusion

This paper develops a formal model to study management's earnings manipulation behavior and its effect on companies' investment decisions. It demonstrates that earnings manipulation is caused by positive at-risk incentive and imperfect monitoring mechanisms. Management has the incentive to move earnings from good periods to bad periods, which suggests earnings smoothing does not depend on the non-linearity of the employment contract.

This paper also shows that in many plausible situations, an increase in the at-risk amount will increase earnings manipulation by the management. This implies at-risk incentive is more expensive than suggested by the standard principal-agent model. It also means we should be more cautious in recommending high-powered executive compensation plan.

Furthermore, this paper shows the ability to manipulate earnings drastically changes the management's attitude towards risk. When earnings discrepancy from previous period is high, the management will be excessively risk seeking, and gamble very risky investment projects. Such recklessness may result in huge losses to shareholders. Paradoxically, an increase in the efficiency of the auditors' work may make the management more risk-seeking and exacerbate the agency problem.

In this paper, we assume the employment contract is exogenous and there is no moral hazard problem in the management's effort levels. One possible direction for future research is to add management's effort to the model. In this case the principal has to deal with two moral hazard problems simultaneously. It is interesting to explore how the ability to manipulate earnings can affect the form of the optimal contract, and empirically whether it can explain the relatively low-powered executive compensation plan observed in most industries.

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