Analytical Models in Earnings Management: A Review

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〔Articles（論説）〕

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Abstract

This paper examines the previous analytical studies to provide the clues for understanding earnings management, while reviewing the literature from preliminary analytical models in accounting information system to the models in earnings management. It can be summarized that the communication between a principal and an agent cannot be identified with the public disclosure to the externals and that the revelation technique may be applicable in a communication process between a principal and an agent, not in the public disclosure process.

1. Introduction

Regarding earnings management issues, the Revelation Principle is known as a "nemesis" (Dye, 1988, p.200) to the study of earnings management because the Revelation Principle induces the same equilibrium in which contracting parties reveal the truth, whatever the equilibrium of the original contract in which contracting parties have private information to manage the firm's earnings. In this way, the Revelation Principle raises a question about earnings management in analytical studies (Ronen and Yaari, 2008, p.xvii).

Therefore, this paper reviews the literature from preliminary models in accounting information system to models in earnings management in order to provide the clues for understanding earnings management.

2. Analytical Models in Accounting Information System

2. 1. Preliminary models in accounting information system

The notion treating accounting system as a measurement-communication system, especially information system, was emerged in 1960s by Statement of Basic Accounting Theory

(1966). After that, managerial accounting researchers gradually differentiated between information system choice (i.e., information system evaluation) and information system design (Scapens, 1991, p.126). The former one is called information evaluating approach by Demski and Feltham (1976), which this study is primarily based on[1]. The information evaluating approach regarded information[2] as a problem of economic choice like a conventional economic commodity, using a decision model with the axiomatic structure.[3] This decision model is subsequently developed into an agency model[4] by agency theory researchers who considered the decision maker's behavior (Scapens 1991, p.145-146).

A preliminary model of Demski (1972; 1980) remains confined to utility functions rather than contracts between two parties. He mentioned the problem of information asymmetry in an information system.; however, a specific incentive compatibility constraint to motivate the agent was not yet devised. Later, Demski and Feltham (1978) and Hölmstrom (1979) focused on contract between a principal and an agent, and designed an agency model to cope with information asymmetry problems. Hölmstrom (1979) has often been cited as a paper which devised an incentive compatibility constraint to moral hazard problem; a tool for solving adverse selection problem was not yet adopted.

Based on the explanations from Demski (1972; 1980), Demski and Feltham (1978), and Hölmstrom (1979), preliminary models in information system prior to considering the Revelation Principle are expressed as Table 1 illustrates.

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[1] Demski and Feltham (1976, 8-9) explains the information evaluation approach in following two cases. One is a decision-facilitating case, where information is provided to the decision maker prior to his decision making, with the purpose of helping "resolve some form of uncertainty in the decision problem at hand." The other is a decision-influencing one, where information is used "to evaluate the decision maker's performance, with the purpose of motivating his action selections."

[2] According to Cristensen and Demski (2003, p.3), the term information is "some observable that reveals something, leading to a change in the probability assessment" and reducing "uncertainty." This way of thinking is affected by a Bayesian revision updating the prior probability to calculate the posterior probability.

[3] Demski (1972) states that "the decision maker's choice problem can be described by specifying the act set A, state set S, probability function ϕ, and utility function U." Under an existing level of decision maker's experience ξ, the set $\{A, S, \phi, U|\xi\}$ can be called a decision model.

[4] The agency model of contract theory focuses on the contract where the principal delegates decision-making authority to the agent, and explains the organization's structure or individual's behavior, based on the mechanism adjusting interests of the related parties behind (Satō et al., 2009, p. 4).

Table 1. Preliminary models in information system

Literatures		Demski (1972; 1980)	Demski and Feltham (1978)	Section 6 of Hölmstrom (1979)
Contract, or sharing rule		(The agent's utility function is only mentioned)	$\mathcal{C} = (q, \mathcal{I}, \eta)$ is a contract, and $x_w = \mathcal{I}(y)$ is the worker's share of the output (where q is the amount of owner's capital, and $y = \eta(s, a, q, h)$ is a function of the observed factors)	$s(x, y)$, $x - s(x, y)$ (where $s(x, y)$ is the agent's share of the outcome)
Time line		$s \to y \to a \to x$	$s \to h \to a \to x$	$\theta \to a \to y \to x$
State of nature		state, s, with p.d.f. $\phi(s|y, \eta)$, where η is an information system	random state factors, s with p.d.f. $\phi(s)$	a random state of nature, θ
Before contracting	Hidden information	N/A	worker's labor skill type, h	N/A
After contracting	Hidden information	signal, $y = \eta(s)$	N/A	z, signal about θ
	Hidden action	effort, a	worker's effort, a	agent's action, $a(z)$
	Hidden information	N/A	N/A	y, signal about a
Outcome		cash flow, $x = f(s, a)$	output, $x = p(s, a, q, h)$	monetary outcome, payoff, $x = x(a, \theta)$ with p.d.f. $f(x, y, z, a)$
Information evaluator or Principal		information evaluator	(e.g. owner)	principal
Decision maker or Agent		decision maker	agent (e.g. worker, employee)	agent (e.g. farm worker)
Context		managerial accounting	managerial accounting, (e.g. budgeting)	cost accounting, or insurance arrangement

Note: The darker-shaded areas represent adverse selection problems; the lightly-shaded areas represent moral hazard problems.

2. 2. Models in Accounting Information System

As previously mentioned, a tool for solving moral hazard problems has been first established in preliminary models. Subsequently, a tool for solving adverse selection problems was devised and it is called the Revelation Principle primarily designed by Myerson (1979). The Revelation Principle facilitate to yield truthful reporting strategy in communicating with messages between the principal and the agent. The contents of these messages are not limited to accounting earnings, but private information of an agent in a broad sense. Based on the explanations from Christensen (1981), Baiman and Evans (1983), and Melumad and Reichelstein (1989), the structure of agency models can be expressed as Table 2 illustrates.

Table 2. Models in accounting information system

Literatures		Christensen (1981)	Figure 6 of Baiman and Evans (1983)	Melumad and Reichelstein (1989)
Contract, or sharing rule		an employment contract, $s(x, m)$	$I(x, m, z)$ is the agent's share of the firm's outcome	$H(\cdot)$, $B(x) - H(\cdot)$ (where $H(\cdot)$ is the agent's compensation function and $B(x)$ is the principal's benefit)
Time line		$\xi \to \alpha, m \to x$	$y \to a, m \to x, z$	$\theta \to a \to z \to x$
Before contracting	Hidden information	N/A	N/A	agent's environment (prior state, type), θ
After contracting	Hidden information	private signal, ξ	y, pre-decision signal about the state	N/A
	Hidden action	agent's act, α	agent's productive input (action), a	agent's action choice, a
	Hidden information	N/A	z, post-decision signal about the state and the agent's action (where $z \in Y$)	$z = w(\theta, a)$, posterior state, production parameter
Communication	Form of communication	message, m	message, m	message, $(\hat{\theta})$
	Revelation Principle	$m(\xi) = \xi$ (Myerson, 1979)	$m(y) = y$ (Myerson, 1980)	$\hat{\theta} = \theta$ RP is applicable.
Outcome		outcome, x with p.d.f. $f(x, \xi | \alpha) = f(x | \xi, \alpha) \cdot f(\xi)$	outcome, x, with p.d.f. $\phi(x, z | a, y)$	outcome, x with p.d.f. $dF(x|z)$, where $z = w(\theta, a)$
Principal		e.g. landlord	(not explicitly specified)	(not explicitly specified)
Agent		e.g. sharecropper	e.g. subordinate	(not explicitly specified)
Context		managerial accounting, e.g. budgeting	management control system, design of decentralized organizations	managerial accounting e.g. issues of delegation

Note: The darker-shaded areas represent adverse selection problems; the lightly-shaded areas represent moral hazard problems; the diagonal-line areas represent a tool to solve the above adverse selection problems.

3. Analitical Models in Earnings Management

3. 1. Models on Communication Issues of Earnings Management

Dye (1983) started to examine the information asymmetry problems in accounting system from the context of earnings management; and then Dye (1988) attempted to explain the reason that it is inevitable for managers to manage the firm's earnings with two sources of shareholders' demand: One is an internal demand for a principal (current share holder) to try to minimize the expected cost of an agent (manager), and the other is an external demand for current shareholders to induce future shareholders to expect the firm's value. Evans and

Sridhar (1996) primarily focused on the internal demand, i.e., the principal-agent problem not to communicate truthfully; thereafter many studies have shown some tendencies to regard problems generated by internal demand as earnings management. Based on the explanations from Dye (1983), Dye (1988), and Evans and Sridhar (1996), the structure of these agency models can be expressed as Table 3 illustrates.

Table 3. Models on communication issues of earnings management

Literatures		Program 3 of Dye (1983)	Dye (1988)	Evans and Sridhar (1996)
Contract, or sharing rule		agent's compensation contract, $s(x, y)$	$s(\cdot)$, the manager's compensation	$s(\cdot)$, the manager's compensation
Time line		$a \to y \to x$	$a \to x, \epsilon \to \hat{y}$ $\to$ allocation	$a \to y_n, \epsilon_k \to y_m$ $\to$ allocation
Before contracting	Hidden information	N/A	N/A	N/A
After contracting	Hidden action	agent's effort level, a	effort level, a	action, a ($V(a)$: disutility of effort)
	Hidden information	y, private post-decision signal correlated with x (e.g. insiders' forecast)	①actual earnings, x ②manager's other private information, ϵ	①$1^{st}$ signal, firm's economic earnings, $y_n \in Y$ ②$2^{nd}$ signal, extent of available reporting discretion, $\epsilon_k \in E$
Internal demand of earnings management	Form of communica-tion	$\hat{y}(y, \hat{a})$, signal to report	message, $\underline{y}(\tilde{x}, \tilde{\epsilon}) \in Y(x; \epsilon)$ (where $Y(x; \epsilon)$ denotes a feasible message space)	message, $\overline{m}(R(y_n, \epsilon_k))$ (where $R(y_n, \epsilon_k)$ denotes a set of feasible messages)
	Revelation Principle	$\hat{y}(y, a) = y$ (Myerson, 1979)	Here, RP (Myerson, 1979) for $\underline{y}(\tilde{x}, \tilde{\epsilon}) = \tilde{x}$ is not applicable, because manager's message space is partially blocked.	Here, RP for $\overline{m}(R(y_n, \epsilon_k)) = y_n$ is not applicable, because a report of ϵ_k is impossible.
	Cost of EM	N/A	$c(\tilde{x}, \hat{y}, \tilde{\epsilon})$: manager's personal costs of EM	$s(y_n) \geq s(y_m)$ for every (y_n, ϵ_k) and $\forall y_m \in R(y_n, \epsilon_k)$
External demand of earnings management	Public display	N/A	reported earnings, $\hat{y}$ i.e., $\hat{y} \equiv \underline{y}(\tilde{x}, \tilde{\epsilon})$)	N/A
	Cost of EM	N/A	$l(x, \hat{y}, \varepsilon)$: the corporate costs of EM	N/A
Outcome		firm's output, x with p.d.f. $f(x, y, a)$	manager's output, the firm's actual earnings, x with p.d.f. $f(x|a)$	the firm's economic earnings/ outcome, y_n with p.d.f. $f(y_n|a)$
Context		managerial accounting	financial accounting	Financial accounting

Note: The darker-shaded areas represent adverse selection problems; the lightly-shaded areas represent moral hazard problems; the diagonal-line areas represent a tool to solve the above adverse selection problems.

Even though the aforementioned studies refer to the Revelation Principle as a countermeasure against earnings management, they cannot apply it to solve an earnings management problem because conditions for the Revelation Principle, such as not being blocked to communicate a manager's private information to a principal, are not satisfied.[5]

3. 2. Models on communication issues in other contexts of earnings management

Studies in other contexts of earnings management have tendencies to differentiate a communication problem between a principal and an agent, from a disclosure issue to the externals, which is a two-stage game with private message and public display; the former one is related to an adverse selection problem, the latter one is related to a moral hazard problem. These clarify that revelation techniques are used only to the communication issue as an adverse selection problem. Based on the explanations from Melumad and Reichelstein (1989), Lacker and Weinberg (1989), Morton (1993), Maggi and Rodríguez-Clare (1995), and Crocker and Morgan (1998), the structure of these models can be expressed as Table 4 illustrates.

3. 3. Recent models on communication issues of earnings management

Aforementioned previous studies lead to the understanding of earnings management issue as *an action* of moral hazard problem, not *a type* of adverse selection problem. Therefore, recent studies show some tendencies to distinguish setting the revelation technique to report *a type* truthfully from setting an earnings management cost function (or, falsification cost function) to minimize the extent of undesirable action. It can be said that the Revelation Principle cannot solve an earnings management problem because the earnings management is one of disclosure issues to the public, such as prospective shareholders in a capital market, not because the assumptions of the Revelation Principle is violated. Based on recent models from Dutta and Gigler (2002), Crocker and Slemrod (2007), and Beyer et al. (2014), the structure of these models can be expressed as Table 5 illustrates.

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[5] Arya et al. (1998) states that the assumptions of the Revelation Principle are "(1) communication is not blocked (it is costless to establish communication channels that allow the agents to report fully their private information), (2) the form of the contract is not restricted, and (3) the principal can commit to use the reports submitted by the agents in any prespecified manner."

Table 4. Models on communication issues in other contexts of earnings management

Topics		Issues of delegation	Contracts with endowment	Auditing with Fraud	Distorting information	Insurance with Fraud
Literatures		Melumad and Reichelstein (1989)	Lacker and Weinberg (1989)	Morton (1993)	Maggi and Rodríguez-Clare (1995)	Crocker and Morgan (1998)
Contract, or sharing rule		$H(\cdot)$, $B(x) - H(\cdot)$ (compensation function, $H(\cdot)$, and principal's benefit, $B(x)$)	$R(y)$, $x - R(y)$ (a transfer function, R)	$x - r$, r (the manager retains the residual, x-r)	y, $V(q) - y$ (revenue for principal, $V(q)$, and a monetary transfer, y)	$C \equiv \{r, p, y\}$ (a variable payment, r, a lump-sum transfer, p, and an action, y)
Time line		$\theta \to a \to z \to x$	$x \to y$ $\to$ allocation	$x \to r$ $\to$ allocation	$\theta \to s$ $\to q$(allocation)	$x \to y$ $\to$ allocation
Before contracting	Hidden information	agent's environment (prior state, type), θ	N/A	N/A	the agent's marginal cost, the private observed state, θ with p.d.f. $f(\theta)$	N/A
After contracting	Hidden action	agent's action choice, a	N/A	N/A	N/A	N/A
After contracting	Hidden information	$z = w(\theta, a)$, posterior state, production parameter	the true endowment, the privately observed state, x	value of the firm, x	N/A	the actual value, x
1st stage (Communication between the principal and agent)	Form of communication	message, $(\hat{\theta})$	message, $\hat{m}(x)$	the private message, χ	(message), θ_r	(message), $\hat{x}$
1st stage (Communication between the principal and agent)	Revelation Principle	$\hat{\theta} = \theta$ RP is applicable.	$\hat{m}(x) = x$ ($\hat{M}$: a message space) ($[\hat{m}(x) = x] \neq y(x)$ is plausible)	$\chi = x$ $[\chi = x] \neq r(x)$ is plausible (Myerson, 1979)	$\theta_r = \theta$ (Myerson, 1979)	$\hat{x} = x$ (Myerson, 1979)
2nd stage (Disclosure to Externals)	Public display	N/A	the amount of endowment "displayed", the observed outcome, the choice, an "action", not a "message", y	the public message, the publicly issued report, $\hat{r}(\chi)$	signal of marginal cost, $s = \theta + e$, (e denotes an unobservable "action" for the agent to distort the signal)	the publicly observed value of x, an "action", y
2nd stage (Disclosure to Externals)	Falsification costs	N/A	amount of falsification, h= $x - y$	the penalty rate, L	amount of falsification, $e = s - \theta$	amount of falsification, $|x - y|$
2nd stage (Disclosure to Externals)		N/A	falsification costs, $g(x - y)$	penalty, $L(x - r(\cdot))$	falsification costs, $c(e)$	falsification costs, $g(x - y)$
Outcome		outcome, x with p.d.f. $dF(x|z)$, where $z = w(\theta, a)$	endowment, x with p.d.f. $dF(x)$	outcome, x with p.d.f. $dF(x)$	output, q	outcome, x with p.d.f. f (i.e., $f = f(x)$)

Note: The darker-shaded areas represent adverse selection problems; the lightly-shaded areas represent moral hazard problems; the diagonal-line areas represent a tool to solve the above adverse selection problems.

Table 5. Recent models on communication issues of earnings management

Literatures		Dutta and Gigler (2002)	Crocker and Slemrod (2007)	Beyer, Guttman, and Marinovic (2014)
Contract, or sharing rule		$s(\hat{x}, y),\quad x - s(\hat{x}, y)$ (the manager's compensation, $s(\hat{x}, y)$)	$\{B(R), w\}$ (a lump-sum transfer, w, and a bonus schedule, $B(R)$)	$w(r),\quad q - w(r)$ (the manager's compensation, $w(r)$)
Time line		$a \to x \to \hat{x} \to m(x), y \to$ allocation	$a \to x \to R \to$ allocation	$\theta \to q \to r \to$ allocation
Before contracting	Hidden information	N/A	N/A	manager's (true) type (inverse of manager's productivity), cost coefficient**, θ with p.d.f. $f(\theta)$
After contracting	Hidden action	a productive effort, a (v_a: disutility of productive effort)	agent's profit-enhancing action, a ($h(a)$: disutility cost of a)	productive effort, q
	Hidden information	economic earnings, the firm's output, x	actual profit of the firm, manager's type, x	N/A
1st stage (Communication between the principal and agent)	Form of communication	the manager's report, or (earnings) forecast*, $\hat{x}$	(reported type), $\hat{x}$ to reveal truthfully manager's type	reported type, $\hat{\theta}$
	Revelation Principle	$\hat{x} = x$ RP is applicable.	$\hat{x} = x$ using a direct revelation mechanism ($[\tilde{x} = x] \neq R(\tilde{x})$ is plausible) (Myerson, 1979)	$\hat{\theta} = \theta$ using a direct mechanism (Myerson, 1979)
2nd stage (Disclosure to Externals)	Public display	accounting earnings report, y ($m(x)$: the manager's choice of manipulative "action" conditional on his observation of economic income, or window dressing "action")	a report about the firm's earnings, $R(\tilde{x})$	reported earnings, reported performance measure, $r = q + a$, (where a means bias, manipulation, or window-dressing "activity")
	Earnings Management costs	$m(x) = 1$ denotes the case of EM	the extent of earnings falsification, $e \equiv R - x$	the manipulation ("discretionary accruals") contained in the manager's report, $a \equiv r - q$
		$v_m \cdot m(x)$ (v_m: disutility of manager's manipulative activities)	g(e): all the costs to the manager of concocting and camouflaging the falsification, including any penalties imposed by the SEC	$\left(^c/_2\right) \cdot a^2$: the manager's personal costs of earnings manipulation
Outcome		economic earnings, the firm's output, x with p.d.f. $Pr(x, y	a, m(x))$	the actual profit of the firm, x with p.d.f. $f(x|a)$	the output, q (the output, q is the manager's productive effort and the firm's true earnings as well)

Note: The darker-shaded areas represent adverse selection problems; the lightly-shaded areas represent moral hazard problems; the diagonal-line areas represent a tool to solve the above adverse selection problems.

4. Summary

This paper performs the literature review on the analytical models in earnings management, and can be summarized: first, the communication between a principal and an agent cannot be identified with the public disclosure to the externals, such as prospective shareholders in a capital market; thus, the revelation technique may be applicable in a communication process between a principal and an agent, not in the public disclosure process. Second, accounting earnings is considered to be appropriate as contracting variables, rather than such *a type* as an environment information of mechanism design. In this sense, earnings management problem recently has been interpreted as *an action* (i.e., moral hazard problem) rather than *a type* (i.e., adverse selection problem) in mechanism design. The analysis in this chapter can provide a helpful framework for designing an analytical model.

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