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AN EVALUATION OF ITAMI'S "ADAPTIVE BEHAVIOR MODEL" AS A MANAGERIAL ACCOUNTING FRAMEWORK USING BAIMAN'S CRITERIA

Simon C. Dzeng*

Introduction

During the past two decades, there have been many proposed managerial accounting (MA hereafter) frameworks published in the literature. The fundamental goal of these frameworks was to provide a convincing and cohesive theory which can explain and analyze some, if not most, of the existing MA practices. Baiman [1982] provided a quite comprehensive review and comparison of some of these frameworks. He approached the task by applying this fundamental logic: "The uses of MA information should be a *derivable implication* of the model rather than an *assumption* of the model." (Baiman [1982], p. 158, emphasis added.) Thus he adopted the test of the usefulness of any proposed model as *whether its derived demands for information include those uses of MA information that are observed.* (p. 158) Baiman identified three major uses of MA information and subjected all models to an analysis using these three uses: belief revision use, motivational use, and risk-sharing use. His conclusion was that the agency model was the only model that is consistent with all of these three observed uses. He then went on to examine the consistency between agency model and several most commonly observed MA practices. The results were that the agency model implications were consistent with four of the six practices. These two sets of results are summarized in Tables 1 and 2, respectively, in this paper.

A somewhat different and non-traditional framework for MA was introduced by Itami [1977] in his innovative monograph **Adaptive Behavior: Management Control and Information Analysis**. He integrated most management control and information analysis features (or observed practices rationale) into a very simple one-period, one or two players, optimal intra-period information (or decision) timing (he called this timing λ) model, the λ -model. Comprehensive and inclusive as it is, however, the model has not attracted much attention since the introduction. For this very reason, a brief synopsis of Itami's λ -model is provided in the Appendix for those who are not familiar with it.

For whatever reason, Baiman did not include the deserving Itami's λ -model as part of his review paper. The purpose of this study is to examine the adaptive behavior model, using Baiman's criteria, and to somewhat expand Baiman's work. The analyses showed that the λ -model is consistent with the three-information-uses criteria, and it is also consistent with the same four out of six MA practices mentioned by Baiman that were consistent with the

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Table 1
Subjecting Agency Theory to MA Info Use Test

Models	Source	Belief Revision	Motivational Use	Risk-Sharing
Decision Theory Model	Feltham [1968]	X		
Syndicate Theory	Wilson [1968]	X		X
Info-evaluator/Decision maker Model & Mathematical Programming Model	Demski/Feltham [1977]; Bailey/Boe [1976]	X	assumed ^a	
Team Theory Model	Marschak/Radner [1972]	X		N/A ^b
Demand Revelation Model ^c	Loeb [1975]; Groves [1975]	X	X	N/A ^b
Agency Model	Alchian/Demsetz [1972]; Williamson et al. [1975]; Jensen/Meckling [1976]	X	X	X

^aBaiman argued that the motivational use of information was assumed by these authors. (See Baiman [1982], p. 160, and footnote 3 on the same page.)

^bN/A in this table indicates that either the design of the models did not address the risk-sharing issue or that Baiman did not discuss it at all.

^cBaiman argued that since this model is "more appropriate for analysing worker cooperatives than capitalist firms," (p. 160) it is inappropriate for the MA discussion at hand.

agency model. Therefore, based on Baiman's criteria at least, λ -model is at least as good as the much more popular agency model.

In the next section, the λ -model will be subjected to the tests of the three information uses suggested by Baiman. The next section contains another test of the common MA practices comparison also done by Baiman. Concluding remarks will end this paper.

Examining the λ -Model With Three Info Uses

According to Baiman [1982], MA information has at least three observed uses:

Table 2
Subjecting Agency Theory to MA Practices Test

MA Practice	Representative Authors	Major Conclusions
Responsibility Accounting	Baiman/Demski [1980]; Holmstrom [1981]	In evaluating and rewarding an agent who controls only part of the firm's output, it may be optimal to evaluate the agent on the basis of the firm's entire output. The key is that even outputs over which the subordinate exercises no influence may contain info that can be used by the supervisor to improve his assessment of the subordinate's action choice.
Budgets	Holmstrom [1979]	The agency model is consistent with the use of budget-based contracts.
Conditional Variance Investigation policies	Baiman/Demski [1980]	The use and form of the one-tail conditional variance investigation MA tool is optimal within an agency context.
Cost Allocation*	Zimmerman [1979]; Demski [1981]	Agency theory does not provide a convincing rationale for cost allocations.
Participative Budgeting	Baiman/Evans [1981]	A rationale was provided for participative budgeting that is an alternative to (but not inconsistent with) the rationale provided by the behavioral literature.
Standards*	Demski/Feltham [1978]	The answer to the question "What does the agency literature suggest concerning the correct choice of standards?" is not yet clearly defined in the existing literature.

*According to Baiman [1982], these two MA practices are not consistent with the agency theory, at least based on the evidence provided by the existing literature.

(1) The *belief revision use* (Simon [1954] calls it *problem-solving use*) — This use of MA information is to improve a manager's *ex ante* assessment of the production environment in order to improve his production decisions.

(2) The *motivational use* — This use of MA information is to help supervisors motivate their subordinates.

(3) The *risk-sharing use* — This use is to facilitate the allocation, among members of the firm, of the risk inherent in operating in an uncertain production environment.

Since the last two uses are interrelated, Baiman referred to them jointly as the *performance evaluation use* of MA information. Simon [1954] calls this the *scorekeeping use*. See Baiman [1982] for more discussions on these.

Belief-Revision Use

Throughout chapters 3, 4, and 5 of Itami's monograph, he talked about the "*ex ante* plan" which is the production plan the manager determines at the beginning of the period. This *ex ante* plan is one of the crucial elements of Itami's model. The manager can come up with a plan like this only if he has access to some previous periods' MA information. Thus the belief revision use of MA information is directly *derivable* from the model's construction. Furthermore, the very core of the adaptive behavior model — the adaptive behavior caused by new information received by the manager at point λ — is the best representation of the concept of belief revision!

Motivational Use

The title of chapter 4 of Itami's monograph is "Budgetary Control and Performance Evaluation with Intrapersonal Adaptive Behavior," which says a lot about the strong motivational implications of his model. Itami differentiates between *ex ante* and *ex post* standards and stresses the motivational aspects of both. The former motivates the subordinates by stating the performance level *expected* of them given previous performance and the forecasted environmental factors (such as macroeconomic variables). (Itami called this the "forward-looking standard.") The latter motivates subordinates by representing a performance level which *should have been* achieved given the appropriate adaptive behavior *and* the actual environmental conditions. (Itami called this the "backward-looking standard.") Therefore, the adaptive behavior model is perfectly consistent with the motivational use of MA information.

Risk-Sharing Use

According to Itami, there are two problems associated with management control under uncertainty: risk congruence and incorporation of adaptive behavior into management control system. These two problems form a tradeoff depending on the "reversability of *ex ante* standard." (Itami defines the reversability of *ex ante* standard as "how much adjustments and revisions are possible after a decision is made." (p. 22 of Itami [1977])) As Itami puts it, "when reversability of an *ex ante* decision is small, risk congruence at the *ex ante* decision control phase becomes very important. When, on the other hand, reversability is large, adaptive behavior becomes more important." (p. 22) Although he recognizes the importance of both problems, he chose to concentrate on the adaptive behavior in his monograph, since he had discussed the risk congruence issue in his other two papers (Itami [1975], [1976]). Because the crux of the risk congruence problem is how much

risk a control procedure or evaluation scheme force the subordinate to *share* the uncertain outcomes, and also given the analysis above, the adaptive behavior model (the λ -model) is obviously *not inconsistent* with the risk sharing use of MA information.

In conclusion, Itami's adaptive behavior model is consistent with the *belief revision* and the *motivational uses* of MA information, but not inconsistent with the *risk sharing* use.

Consistency With MA Practices

Baiman used six MA practices simply because of their common use. This list is not supposed to be exhaustive.

Responsibility Accounting

Responsibility accounting states that a person should be evaluated only on the basis of those factors that he controls. Baiman found that agency theory is in general consistent with responsibility accounting except for some narrow interpretation differences. Itami addresses the issue of "controllable and uncontrollable" parameters in his λ -model (p. 68, also refer to Appendix of this paper for definitions of the parameters). He mentioned that "when parameters exist in the λ -model (c, A, b) whose values may change from period to period but whose variations are considered controllable by the subordinate to a substantial degree, we need to distinguish between uncontrollable and controllable parameters." (p. 69) The spirit here is obviously consistent with that of the responsibility accounting. Itami even went one step further to include a controllable parameter variance (CPV) term in his total variance equation for variance analysis, which will be discussed later.

Budget-Based Compensation Schedule

Baiman found that the agency model is consistent with the use of budget-based payment schedule (contract). In Itami's model, the *ex ante* standard can be thought of as the normally defined *budget*. Since the subordinate's compensation is based on his performance evaluation, which is in turn a function of the variance analysis using both the *ex ante* and *ex post* standards (the former is nothing but the expected value of the latter), Itami's λ -model can be said to be consistent with budget-based payment schedule. (See equation 4.2 and 4.3 on p. 61.)

Conditional Variance Analysis

Baiman also found agency model consistent with this MA practice. Given the thorough discussion and analysis of the *ex ante* and *ex post* standards and variance analysis based on them, one can almost automatically conclude that the λ -model is consistent with the common conditional variance analysis practice in MA. In fact, Itami's elaborate variance analysis is far more complex and comprehensive than most variance analysis models ever been suggested. His most complete variance analysis equation

($TV = AV + CPV + FEV + UV$, see equations 4.8 and 4.9 on p. 69) incorporates elements such as adaptation variance (AV), controllable parameter variance (CPV), forecast error variance (FEV), and uncertainty variance (UV) of the total variance (TV).

Participative Budgeting

Baiman also found agency model consistent with the participative budgeting practice. On this issue, Itami notes "participation is beneficial when it succeeds in two influencings — goal influencing and consequence influencing. The subordinate's personal goal may be influenced by participation through the better chance of acceptance or internalization of what is agreed upon by the subordinate. The consequence factor in the mind of the subordinate may be influenced by participation through making reward structures clearer to him." (p. 19) This, plus the detailed discussions on the communication between the subordinate and the superior about the reasonable production plan and the forecasts of the environmental factors in chapters 3 through 5, we must say that Itami's λ -model is consistent with the participative budgeting practice.

Standards

Unfortunately, Baiman concluded that agency model's ability to suggest the correct choice of standards (points at which the nondifferentiability of the budget-based payment schedule occur) is not yet well explored. Itami's λ -model is also weak in this respect. Although he has quite thorough discussions on the theoretical definitions and implications of *ex ante* and *ex post* standards, the model does not seem to help managers set the optimal standards at an operational level.

Cost Allocation

Although being able to suggest a possible rationale for this common MA practice, Baiman concluded that agency model's ability to explain this practice is not yet clear. Since Itami did not mention this practice at all in his monograph, we can only speculate, based on his thesis, that λ -model is not able to explain it either, at least now and from the surface.

In conclusion, Itami's λ -model is consistent with at least four out of the six MA practices used by Baiman. The two that do not seem to be consistent now may well be shown to be consistent in the future literature. Besides, Itami did mention another common MA practice of *interim reporting* which can not only be explained well by λ -model, but also benefit from the model's analysis to determine the optimal timing of reports.

Conclusions

In this paper, I have used Baiman's [1982] criteria to examine Itami's [1977] adaptive behavior model (λ -model) and found that the model's uses of MA information are consistent with the three info uses Baiman suggested: belief revision, motivational, and risk sharing. I also found that the λ -model is con-

sistent with four common MA practices suggested by Baiman and one mentioned by Itami himself: responsibility accounting, budget-based payment schedule, variance analysis, participative budgeting, and interim reporting. Two MA practices were not well explained by Itami's model: cost allocation and standard setting. Overall, however, λ -model did very well as far as Baiman's criteria set is concerned. Agency model was the only one of the seven reviewed by Baiman that met all three uses test. It is also consistent with four out of six MA practices. From this point of view, the λ -model fares at least as well as the agency model as a managerial accounting framework.

The question then arises: why didn't λ -model gain as much popularity and attention as agency model did since the 70's? The answer to this question may have to await future research. One possible approach is to compare the λ -model and the agency model directly against each other. This comparison, presumably focusing on the different assumption sets and linear programming model parameters, should shed some light on this question. For example, the λ -model seems to have a much more detailed and specific assumption set about the information flows and intraperiod adaptive behavior than the agency model does. If this were the case, it would certainly make it much more difficult to model and analyze, especially when we try to apply it to the real world. It is also obvious that the λ -model has a lot more stochastic parameters modelled in the linear programming form compared to the agency model, thus dramatically increasing the complexity of the problem-solving and analysis processes. Nevertheless, given the strong theoretical and practical implications of the λ -model that we found in this study, it appears worthy for MA researchers to explore the much neglected implications of the λ -model.

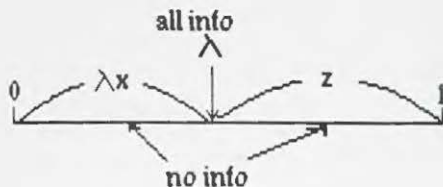
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Appendix: Synopsis of Itami's Adaptive Behavior Model, the λ -Model

The easiest way to understand the λ -model probably is to first take a look at the following time line:



1. Sometime between the beginning and the end (i.e., 0 and 1) of the period, the manager (the person who is relegated the responsibility for the whole operation) can acquire *perfect* information on the value of actual demand for the entire period (ξ) denotes this information point and $0 \leq \lambda \leq 1$. Before λ , there is no additional information on demand other than what the manager already had at the beginning of the period (i.e., the probability distribution of ξ); and after λ , there is no uncertainty left.
2. From time 0 until time λ (called the *preinformation subperiod*), the operation is carried out according to whatever production plan the manager had determined *for the entire period* at the beginning (Itami calls this plan an *ex ante* plan and denote it by x) at a *uniform* rate with respect to time. Thus, by time λ , the firm will have produced λx units of the product.
3. From time λ until time 1 (called the *postinformation subperiod*), the operation is carried out at a new production rate which is determined to maximize the net profit for the now-known value of the actual demand for the period, given the fact that it has already produced λx . Denoting the amount of production in this subperiod by z , the total production for the entire period is $\lambda x + z$.
4. For production during the postinformation subperiod, a capacity constraint exists proportional to the length of this subperiod, that is $0 \leq z \leq (1 - \lambda)d$. (d is the overall capacity).
5. It is assumed that there is no changeover cost due to a change in the production rate for the postinformation subperiod (i.e., a change from $(1 - \lambda)x$ to z).

This adaptive behavior model can also be presented in the form of a linear programming form with two separate stages: the first depicts the overall periodic planning model, called (G); while the second describes the postinformation subperiod optimization model, called (G2).

$$(G) \quad \max cx - py^+ - qy^-$$

$$x, y^+, y^-$$

$$\text{s.t. } Ax + y^+ - y^- = b$$

$$Bx \leq d$$

$$x, y^+, y^- \geq 0$$

Considering a firm producing m products using n activities under k capacity constraints. x is a vector of activity levels and Ax is a vector of the amounts of m products, where A represents a matrix of technological production coefficients of each activity. b is a vector of market demands for m products. y^+ and y^- are vectors of shortage and surplus for each product. Capacity utilization is assumed to be linear in terms of activities and represented by Bx , where B is a matrix of capacity utilization coefficients for each activity and capacity. d represents the limits of capacity utilization for the entire period. c is a vector of net profit for each activity per unit operation and p and q are vectors of linear penalty for shortage and surplus respectively.

Thus, for any *ex ante* plan x and actual parameter values now known at time λ , the decision for the postinformation subperiod can be determined by the following *second-stage* linear programming model, called (G2):

$$(G2) \quad \max c(\xi)z - py^+ - qy^-$$

$$z, y^+, y^-$$

$$\text{s.t. } A(\xi)z + y^+ - y^- = b(\xi) - \lambda A(\xi)x$$

$$Bz \leq (1 - \lambda)d$$

$$z, y^+, y^- \geq 0$$

where z ($n \times 1$ vector) is the second-stage decision variable (or postinformation equivalent of x).

Besides these basic models, Itami also provided numerous numerical examples and extensions of the model in his monograph. Interested readers are encouraged to refer to the original monograph.

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