Analytic Modeling in Management Accounting Research

by

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abstract

This Chapter examines analytic or modeling based research, but with an emphasis on the broader perspective of viewing research as a portfolio of investment projects. I stress three keys to good modeling: primacy of the research question, preparation of the model, and the Ralph test. I also identify dominant themes in the recent literature.

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Analytic Modeling in Management Accounting Research

This Chapter focuses on modeling in management accounting research. In this context, modeling refers to the representation of a concept or process, while analytical refers to the use of deductive logic. On the surface, this takes us into the realm of “research method.” But, you will see, I step lightly on this subject and concentrate on the more fundamental issues of interpretation and assimilation.

In particular, this is not a tutorial or a survey. Rather, it is an invitation to reflect, to put modeling in its proper perspective. Following some background remarks aimed at research methods I discuss what I consider to be the three keys to good modeling: primacy of the research question, proper preparation of the model, and what I call the "Ralph test." From there I turn to dominant themes in the literature: hyper vs. muted rationality on the part of the present and implied actors. Some concluding remarks round out the Chapter.

1 background remarks

Research refers to diligent, systematic inquiry. In its broadest sense accounting deals with particular institutions, such as formalized measurement and reporting inside a firm, an audit firm per se, care and feeding of financial information aimed at an organized trading market, and so on. Accounting research, then, refers to diligent, systematic inquiry into institutional regularities. It is a social science exercise in which we use the window of accounting institutions to study behavior, at both the organizational and individual levels. In broad terms we study such things as (1) organizational arrangements, including divisionalized structures, alliances and allocation of decision rights; (2) decision methods and frames; (3) evaluation and compensation, including costing systems; (4) governance structures; and (5) the comparative advantage of the accounting system with its elaborate, nested controls and professional management. Moreover, we do this in a variety of settings, real and imagined, using a variety of methods.

Regardless, the overriding concept is to focus, laser-like, on the issue at hand. This necessitates a focus on first order effects. The more subtle nuances are purged from the analysis. When studying an ABC implementation we do not identify precisely the firm’s technology (e.g., via estimation of a translog model using industry data), nor do we delve deeply into the implementation team’s

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1 The Christensen and Feltham volumes are the starting point for anyone interested seriously in the topic. Recent reviews commissioned by the Journal of Accounting & Economics (Volumes 31 and 32) should also be consulted, along with appropriate chapters in this Handbook. Christensen and Demski (2002) is a particular favorite.

2 Viewing research as constructing or estimating a Taylor series approximation is a useful metaphor. In turn, management accounting research is accounting research in which management’s behavior is a first order concern. Notice how we now merge into the realm of auditing or financial reporting improprieties!
psychological profile. Similarly, when studying managerial compensation we abstract from an overwhelming array of information flow, tax, and implicit factors. Sims (1996, p 105) is particularly insightful when he states: “Advances in the natural sciences are discoveries of ways to compress data concerning the natural world – both data that already exists and potential data – with minimal loss of information.”3

Successful examples of understanding this art form include option pricing, where transaction costs are ignored, the personal cost term in an agency model, where consumption at work, as in Stafford and Cohen (1974), is surrogated by a generic personal cost assumption, or an ABC model where a variety of cost drivers are used as a substitute for identifying the underlying commodity space, as in Debreu (1959) or Christensen and Demski (1997). Moreover, one should not think reliance on first order effects is confined to modeling. Empirical compensation studies, such as Gibbons and Murphy (1992), or experimental evaluation studies, such as Hackenbrack and Nelson (1996), come to mind.

Two implications follow. First, no research exercise is perfect. Moving from the research exercise to the issue under study always focuses on first order effects and therefore always carries an error term. A model is not going to be perfect (though we certainly hope its logic is), just as the presumed controls in an experimental investigation are not going to be perfect. Errors are always present. Get used to it!

Some errors are, of course, egregious. In good research, however, second order errors are tolerated because pushing them to the background helps us focus on the issue at hand. This is Sims’s compression idea at work.

The second implication is less comforting: we know very little about how to sort among potential error patterns. This is the art dimension to good research. The ageless adage is appropriate: I’ll tell you when I see it! Study of art history is essential for the budding fine artist, just as study of accounting research history is essential for the budding accounting researcher. Yet I fear we give short shrift to the art of doing good research, including the importance of extended study of our own "art history."4

Of course, the Blackwell Theorem has something to say here. We know (e.g., Blackwell’s classic “Comparison of Experiments”) that one research program is better than another if the errors in the second can be modeled as if they are statistically equal to the errors of the first plus noise.5 To paraphrase, suppose there is an uncertain state of the world or forthcoming event that will take on one from among a given list of possible events or states. Denote the possible events

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\[ \text{3Closely related is Ijiri's (1971) treatise on the theory of aggregation. Likewise the Heisen-}
\[ \text{berg Uncertainty Principle guarantees limits to the power of observation in the physical sci-}
\[ \text{ences, just as we know people respond to the way they are measured.}
\[ \text{4Pursuing the art history metaphor, a wide variety of literature reviews has been published,}
\[ \text{though none is a sufficient statistic for the underlying work: See Baiman (1982, 1990), Demski}
\[ \text{5This was subsequently discovered to also hold the key for identifying when one random}
\[ \text{variable is “more risky” than another, e.g., Rothschild and Stiglitiz (1970). So, at the risk}
\[ \text{of sounding apocryphal, one research exercise is better than another if it is less risky. Think}
\[ \text{about it.}
\]
or states by the set \( \{ \theta_1, \theta_2, ..., \theta_m \} \) for some \( m > 1 \). In turn, an experiment or information source is available. It will result in one possible observation from among the set \( \{ z_1, z_2, ..., z_n \} \) for some \( n > 1 \). The probability that observation \( z_i \) is observed if state or event \( \theta_k \) is true is denoted \( \pi_{ik} \) (for \( k = 1, ..., m \) and \( i = 1, ..., n \) of course). Now suppose a second experiment or information source is also possible. It will result in one possible observation from among the set \( \{ \tilde{z}_1, \tilde{z}_2, ..., \tilde{z}_\tilde{n} \} \) for some \( \tilde{n} > 1 \). The probability that observation \( \tilde{z}_j \) is observed if state or event \( \theta_k \) is true is denoted \( \tilde{\pi}_{jk} \). Think of this as a choice between experiment \( \Pi \), the first, and experiment \( \Pi \), the second.

It turns out experiment \( \Pi \) is as good as experiment \( \Pi \) regardless of remaining details if and only if there exist real numbers \( b_{ij} \geq 0 \) for \( i = 1, ..., n \) and \( j = 1, ... \tilde{n} \) such that (1) \( \sum_{j=1}^{\tilde{n}} b_{ij} = 1 \) for all \( i = 1, ..., n \) and (2) \( \tilde{\pi}_{jk} = \sum_{i=1}^{n} b_{ij} \pi_{ik} \).

Unfortunately, most research options are non-comparable in the Blackwell sense. For example, would you rather study pricing behavior in an experimental market or by estimating a structural model using actual pricing data; or would you rather assume Bertrand or Cournot competition in your model? This is why the art side of the equation is so important. It is also why I, personally, am quick to admonish those who advocate a particular method or style of modeling.

Lingering somewhat longer on the soapbox, the error fact combined with the Blackwell observation ensure various research exercises are best thought of as complementary attacks on the issues at hand. Trade among method specialists is essential. Moreover, just as modern finance taught us to think in terms of portfolios and an efficient frontier, we would benefit from a portfolio view of accounting research, one where individual researchers and the research community focus on the entire portfolio of research and the importance of being on the efficient frontier.

2 keys to good modeling

Now, just as we look for structure in poetry or in the impressionism movement, let’s look for structure in the application of the research art form. Doing so, however, requires a caveat. There is no recipe, no algorithm that, if followed faithfully, will produce good research. Rather, we are in the realm of a poorly understood art form. What follows, then, are some personal, suggestive and possibly useful observations.

On the surface, the structure of a research exercise is amazingly simple: we specify the relationship between some independent variables and a dependent variable. Think of this, tentatively, as \( y = f(x) \), where \( y \) is the dependent variable of interest, say someone’s expected utility or profit, social welfare or a vector of marginal cost estimates, and \( x \) is a set of independent variables. \( f \), of course, is the specified relationship.

Typically we partition the independent variables into those that are controllable, say \( x_c \), and those that are uncontrollable, say \( x_u \). This gives us the expression

\[
y = f(x_c, x_u)
\]  

1
In this fashion we sharply distinguish the exogenous, the uncontrollable, \( x_u \), from the endogenous, the controllable, \( x_c \).

To illustrate, \( x_c \) might be an individual’s action and \( x_u \) a Savage-style state variable that encodes the fundamental uncertainty. \( f \), in turn, is the expectation of the individuals utility with respect to his subjective probability measure; and \( y \) is the individual’s resulting expected utility. From here, suppose the individual has the option to select \( x_c \in X_c \). We then formulate his choice problem as a seemingly straightforward maximization:

\[
y^* = \max_{x_c \in X_c} f(x_c, x_u) = f(x_c^*, x_u)
\]  

(2)

The preferred option, the best choice, here denoted \( x_c^* \), is the one that maximizes the criterion function, resulting in a maximum value of that function, denoted \( f^* \). For later reference the role of \( x_c^* \) as a maximizing choice is denoted

\[
x_c^* \in \arg\max_{x_c \in X_c} f(x_c, x_u)
\]

Alternatively, \( y \) might be a vector of marginal cost estimates for a multiproduct firm, \( x_c \) a tentative production schedule, and \( x_u \) a set of shocks to the system. \( f \) is now some specific product costing method, say some elaborate ABC procedure.

Continuing, a variable being controllable begs the question of controllable by whom. This calls for more partitioning. Now partition \( x_c \) into \( x_{c1} \) and \( x_{c2} \), where \( x_{c1} \) is controllable by one individual and \( x_{c2} \) is controllable by a second individual. The two individuals might face simultaneous choices, respectively, of \( x_{c1} \in X_{c1} \) and \( x_{c2} \in X_{c2} \). Paralleling (2), but with the introduction of idiosyncratic evaluation measures and hopefully obvious notation, the pair \( x_{c1}^* \in X_{c1} \) and \( x_{c2}^* \in X_{c2} \) reflect equilibrium choices if each is a "best response" to the other in the sense that if one selects his equilibrium choice the best the other can do is select his equilibrium choice:

\[
x_{c1}^* \in \arg\max_{x_{c1} \in X_{c1}} f_1(x_{c1}, x_{c2}^*, x_u)
\]  

(3)

and

\[
x_{c2}^* \in \arg\max_{x_{c2} \in X_{c2}} f_2(x_{c1}^*, x_{c2}, x_u)
\]

Alternatively, as in, say, an agency model the first player’s choice might be observed by the second player before making his choice. Think of \( x_{c1} \) as the evaluation and compensation specification along with action choice instructions and \( x_{c2} \) as the subsequent action choice. The first player now faces the following constrained choice:

\[
y^* = \max_{x_{c1} \in X_{c1}} f_1(x_{c1}, x_{c2}, x_u)
\]  

(4)

subject to

\[
x_{c2} \in \arg\max_{x_{c2} \in X_{c2}} f_2(x_{c1}, x_{c2}, x_u)
\]
In turn, we might envision multiple agents, double moral hazard wherein the first player must also constrain his own choice so its eventual execution is incentive compatible. And with slightly more imagination we can encompass repeated or multi-period settings, agent replacement, explicit information structures, implicit and explicit contracts, renegotiation and what have you.

It is the general pattern, however, that should not go unnoticed. We work with some detailed relationship between independent and dependent variables. Of course, specifying the variables and their relationship is what provides the key to successful representation; and it is here the analogy to good art takes on its full meaning.

2.1 primacy of the research question

The beginning point of a research project is the question that is to be explored, if not answered. We face an indescribably rich set of possible questions, and it behooves us to select carefully the ones in which we are going to invest. We study broadly various aspects of research and development and the importance of informed, imaginative project selection, yet we seemingly take a casual view of asking the right question, of selecting the best project, when it comes to our own research. A good question, in my judgment, is one that is interesting and potentially important, one that can be explored in depth if not answered, and one for which the researcher passionately wants to know the answer.

Some questions are just not very interesting. Examining how a manager uses a particular information source, without controlling for other information sources, is just not very interesting. The sources interact, and this is likely to be a first order effect. Value relevance studies merit a similar comment. Building a model, where we can control the interaction by assuming there is no other information source, allows us to answer the question; but learning the answer is hardly worth the resources consumed in ferreting it out. Similarly, studying how cash compensation varies with various performance measures is not very interesting; compensation comes in many forms and is spread across many periods. Without controlling for substitutes, including time of delivery, we focus on a question that is simply not important, because it has not been framed in a total compensation framework. Likewise, examining decentralized management though coordinated choices in a transfer pricing setting where we assume each manager blindly maximizes the expected value of his division’s income is not very interesting, because it ignores the effect well designed evaluation and compensation arrangements – including performance shares or options, access to a bonus pool and promotion prospects – might have on the performance of the arrangement. The same can be said about minor variations on a well examined theme.

Other questions are interesting and potentially important but, so far, well beyond our reach. The role played by compensation consultants, both at the individual firm and across an industry comes to mind. Here we have repeated play, changing, renegotiated if you will, trade arrangements, anticipation thereof, and the potential for herding on particular arrangements. Similarly, the time at
which a firm would find a major ABC style intervention worthwhile is a fascinating question. But this entails a conscious decision to disrupt the information cues and terms of trade in an organization, and to do so in a way that consumes serious resources, disrupts established relationships, and what have you.\footnote{Anderson and Young (1999) and Anderson et al (2002) as well as Demski et al (2004).}

Finally, an important question that can be explored seriously will likely be treated to second class imagination and effort if the researcher himself is not passionately interested in the question. Good academic research moves us forward, stretches our understanding, expands our horizon. This requires skill, luck and tenacity.

### 2.2 proper preparation of the model

The second key to good analytic research in management accounting is proper preparation of the model. Glance back at (1). With a question in mind we structure controllable and uncontrollable variables in such a way as to shed light on the question. The comparative advantage of modeling work, of course, is internal validity. This translates to the admonition: never ask a model a question it has not been prepared to answer. For example, there is little point to formulating a model under presumed certainty and then asking what information is "needed" to implement that model. Certainty presumes you know the parameter values in the model! Similarly, using presumed certainty to examine transfer pricing policies amounts to asking the model how to organize production while simultaneously assuming the answer is common knowledge.\footnote{Milgrom (1981) provides an axiomatization of common knowledge.}

The dual to this adage is if a model is well prepared to answer a question it follows that the underlying issue arises naturally in the model. If cost allocation is the issue, the model should exhibit some demand for cost allocation in the first place; if performance evaluation is the issue, the model should exhibit some demand for performance evaluation; if costing is the issue, the model should exhibit some concern for marginal cost estimation. Similarly, as in Hansen (1998), if cost reduction incentives are to be linked to competition, the well prepared model exhibits both uncertainty and competition; and, as in Gigler and Hemmer (2001), if management’s disclosure policy is at issue the model should be founded on endogenous communication. Likewise, a model well prepared to analyze pricing heuristics should, presumably, step beyond monopolistic settings, as in Balakrishnan and Sivaramakrishnan (2002), and embrace entry, exit, partial substitutes, and product innovation, though we are now pushing on the frontier of tractability.

Regardless, representation is the workhorse here. Typically we assume individual behavior can be represented by expected utility maximization. Literally, we assume the individuals behave as if they have identified a preference measure and maximize its expectation with respect to an identified probability measure, Kreps (1988) and Savage (1954). Notice, however, this also commits the analysis to Bayesian information processing at the individual level.
We also encounter frequent use of the Revelation Principle, another representation device, wherein the equilibrium in a formal game can be represented as if the players exercised fully revealing, incentive compatible communication, Myerson (1979) and Harris and Townsend (1981). Here, however, we commit the analysis to settings where the underlying message space or language costlessly tolerates full communication, where incentive arrangements are optimal, and where commitment is unquestionable.8

Suppose, then, we take the view that earnings management take place when management knows the underlying details but opportunistically mis-reports those details. It then follows that a setting where the Revelation Principle applies is particularly ill-suited for the study of earnings management, simply because the model, by design, is not prepared to host equilibrium opportunistic garbling of the known, underlying information, in any serious fashion. Arya, Glover and Sunder (1998) use this observation to categorize studies of earnings management according to which of the legs of the Revelation Principle they violate, and thereby begin with a well prepared model.9

2.3 the Ralph test
A third key to good modeling is what I call the Ralph test. I have long thought research and teaching are interdependent. And a useful exercise is stylize a research project, the author is irrelevant at this point, to the point it can be brought into the classroom. Is the central question in the research project of any classroom importance? If not, it is not very likely the original research project was well conceived. Similarly, is the answer that the research provides to this central question of any use? If it is so hypothetical, say, that it leads to vacuous classroom exploration it is, again, not very likely the original project was well conceived.

Our research is, recall, a social science exercise in which we use the window of accounting institutions to study behavior. The classroom, in my mind, provides the acid test of whether our research is fulfilling this promise.

3 dominant themes in the literature
The analytic modeling literature addresses a wide variety of questions, is predominantly economic in nature, and, again speaking in generalities, takes an aggressive or muted approach to rationality. This divergence goes back to pioneering work by Simon and Muth in the 1950s. (Sheffrin (1996) and Sargent (1995) are excellent sources.) Though both were working on the same broad

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8 Staying on the subject of representation, notice the aforementioned Blackwell Theorem is a statement about our ability to represent the outcomes of an experiment.
9 Demski et al (2004) provide a model in which opportunistic garbling is designed into the information structure per se, by the manager devoting effort to making his "numbers" biased in his favor, as opposed to biasing what he already knows; and Dutta and Gigler (2002) model "window dressing" in this fashion.
class of problems, understanding trade arrangements, Muth stressed hyper-
rationality in his insistence on self-fulfilling expectations, while Simon stressed
muted-rationality, in his insistence on cognitive limitations. This distinction
persists.

Performance evaluation is a case in point. Holmstrom’s (1979) model, hav-
ing been well prepared by capitalizing on the transformation of variables inspired
by Mirrlees, asked an optimal contracting model how it would use additional
information. This exposed a flaw in the controllability folklore, and also led
to Gjesdal’s (1982) demonstration that the Blackwell extension to a contracting
setting is decidedly one-sided. But, just as when we invoke expected utility
representation we thus commit the model to Bayesian processing, when we in-
volve unconstrained contracting we thus commit the model to extracting every
nuance from the full vector of contractible variables. No prisoners are taken,
so to speak. The model is cognitively unlimited in exploiting all contractible
variables.

A similar route is taken when we wed unrestricted contracting with (oppor-
tunistic) earnings management, or even contract renegotiation. Contracting in
such a setting is fully endogenous, earnings management is, well, fully orches-
trated, anticipated and sustained as equilibrium behavior.

The other side of this coin is the linear contract (actually, affine contract)
industry where we expressly limit the contract form. Examples are provided
by Feltham and Xie (1994), Indjejikian and Nanda (1999) and Christensen et
al (2005). Here we are asking vastly different types of questions, questions
aimed at understanding specific, exogenous limitations on contract form, in the
interest of tractability or lip service to transaction costs. But the answers are
remarkably different. We even wind up with a demand for redundant per-
formance statistics simply because they increase the contract space. Hemmer
(2004) is particularly eloquent in pointing this out. It also turns out that unin-
tended opportunism can be efficient in this setting, because it too expands the
contracting arrangements.

The unfettered contracting approach puts all transaction and cognition is-
ssues in the realm of second order concerns, just as the linear contracting ap-
proach puts them on the shoulders of an explicit, highly active (in the model)
resolution. Work in both areas is likely, in my opinion, to move us forward.
In a larger sense, this returns us to themes begun by Muth and Simon. Sar-
gent (2001) describes how blending these themes helped us understand macro-
economic issues and effectively guide policy. And calls for mixing, though rare,
can be found close to home, e.g., Covaleski et al (2003) and the early work of
Charnes and Stedry (1964). It is important to remember the portfolio perspec-
tive!

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10 This is another illustration of the importance of preparing the model to host the question
at hand. Spence and Zeckhauser (1971) employed the usual state-act-outcome formulation,
which proved intractable. Mirrlees (1999), in a famous working paper that was published
decades later, provided a change of variables that set the stage for Holmstrom’s work.
4 concluding remarks

Research and instruction in accounting both strike me as too aggressive in partitioning the subject, and presuming interaction effects are second order. Holding forth on the subject of modeling in management accounting is a case in point. Management accounting, broadly conceived, is concerned with accounting related questions wherein management’s behavior is a first order concern. This quickly brings us to the world of auditing, not to mention financial reporting as well. Similarly, modeling is but one method, and interactions among methods are the very essence of collective mature research programs.

That said, any research project (in accounting or otherwise) should, in my opinion, reflect primacy of the underlying research question, proper preparation of the medium (model, data, experiment) to host the question of interest, and, of course, the ultimately pragmatic Ralph test.

5 references


