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Accounting Theory as a Bayesian Discipline

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Accounting Theory as a Bayesian Discipline

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ABSTRACT

The Bayesian logic of probability, evidence and decision is the presumed rule of reasoning in analytical models of accounting disclosure. Any rational explication of the decades-old accounting notions of "information content", "value relevance", "decision useful", and possibly conservatism, is inevitably Bayesian. By raising some of the probability principles, paradoxes and surprises in Bayesian theory, intuition in accounting theory about information, and its value, can be tested and enhanced. Of all the branches of the social sciences, accounting information theory begs Bayesian insights. This monograph lays out the main logical constructs and principles of Bayesianism, and relates them to important contributions in the theoretical accounting literature. The approach taken is essentially "old-fashioned" normative statistics, building on the expositions of Demski, Ijiri, Feltham and other early accounting theorists who brought Bayesian theory to accounting theory. Some history of this nexus, and the role of business schools in the development of Bayesian statistics in the 1950–1970s, is described. Later developments in accounting, especially noisy rational expectations models under which the information reported by firms is endogenous, rather than unaffected or "drawn from nature", make the task of Bayesian inference more

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difficult yet no different in principle. The information user must still revise beliefs based on what is reported. The extra complexity is that users must allow for the firm's perceived disclosure motives and other relevant background knowledge in their Bayesian models. A known strength of Bayesian modelling is that subjective considerations are admitted and formally incorporated. Allowances for perceived self-interest or biased reporting, along with any other apparent signal defects or "information uncertainty", are part and parcel of Bayesian information theory.

1

Introduction

This monograph introduces Bayesian theory and its role in statistical accounting information theory. Its intended audience includes accounting PhD students and researchers. The Bayesian statistical logic of probability, evidence and decision lies at the historical and modern epicenter of accounting thought and research. It is not only the presumed rule of reasoning in analytical models of accounting disclosure but also the default position for empiricists when hypothesizing about how the users of financial statements think:

> Based on Bayesian decision theory research (e.g. DeGroot, 1970) that shows that loss-minimizing investors place less weight on noisier (i.e. more uncertain) information, we expect to observe more muted initial market reactions to unexpected earnings signals that have higher information uncertainty. (Francis *et al.*, 2007, p. 408)

Bayesian logic comes to light throughout accounting research. It is the soul of most strategic disclosure models, for the reason that any other model of investor behavior implies an incoherence or inconsistency in beliefs and actions by which the investor will overall surely lose to a more coherent market or opponent:

> In theory-based, economic analyses, reliance on Bayes rule is so routinized an assumption as rarely to warrant any justification. The compelling feature of Bayes rule is that it implies the most efficient use of information. Consequently, in market settings, investors who use information more efficiently (i.e. Bayesians) should be able to exploit and dominate their less efficient counterparts. (Verrecchia, 2001, p. 123)

Bayesianism is similarly a large part of the stated and unstated motivation of empirical studies of how market prices and their implied costs of capital react to better financial disclosure. Investors are taken to impose discount rates or costs of capital consistent with their best possible (i.e. most rational) probability assessments.

Summarizing their philosophical position, Chen and Schipper (2016) argued for theory to play a greater part in accounting PhD programs and in empirical research designs. Their view of accounting is overtly Bayesian. They highlight the role of accounting measurements as information for fundamental analysis, which is understood as the formation of beliefs about the firm's cash flows and risks, culminating in financial investment decisions:

> Analyses of different accounting measurement attributes (for example, fair value and historical cost) illustrate the potential benefit of using theory to discipline empirical analysis. A general question that accounting researchers are interested in is whether accounting measurements matter, in the sense of whether different accounting measurement attributes for the same item lead to differences in investors' assessment of firms' fundamentals and therefore affect investors' decision-making. (Chen and Schipper, 2016)

Similarly, Barth (2006b) notes an array of market effects that are indicative of accounting information having met its objective, namely to alter investors' beliefs and thus actions:

> Some [empirical research] designs use capital market metrics, other than equity market value, such as trading volume,

> cost of capital estimates, and bond ratings. These studies help to provide insights into the role of accounting in capital markets. Beaver (1968) is the seminal paper in this literature and shows that accounting information changes investors' beliefs by showing that trading volume increases at earnings announcement dates. (Barth, 2006b, p. 95)

It could be argued that using information for decision-making — and hence logical (i.e. Bayesian) reasoning — all goes without saying. The retrospective provided by Chen and Schipper suggests otherwise. They explain that even theoretically formal and rigorous valuation models, like the Ohlson residual income model, are essentially non-Bayesian, because they feed accounting information into a finance-based valuation model rather than feeding Bayes theorem. Any implicit belief revision upon the Ohlson framework is not brought to light:

> This valuation approach does not model how investors use accounting information to update their beliefs about firms' future dividends. Therefore, the value relevance literature circumvents what some might view as a basic question to be asked about differences in accounting measurement attributes, namely, do the different measurements indeed result in differences in information used by investors. Furthermore, because the valuation model is silent on what "information content" and "value relevance" mean and how they are affected by different measurements, it has limited ability to guide research designs and to help researchers draw meaningful inferences. Consequently, much of the existing literature has relied on ad hoc specifications, and focused on assessments of explanatory power and assessments of regression coefficients linking accounting outcomes such as earnings to market outcomes such as price or return. Absent a theory or at least an analytical structure explicitly considering investors' use of information (e.g., investors' prior, Bayes updating), the interpretations of these results must of necessity be ad hoc. . . . We are not implying that the residual

> income frameworks revived by Ohlson (1995) and others have no value. In fact, we believe this research provides useful insights on the role of accounting measurement. Our point is that this research is not suitable to answer questions related to how investors use accounting data to update their assessments of estimates of future cash flows. (Chen and Schipper, 2016)

Any attempt to explicate the decades-old accounting notions of "information content", "value relevance", "decision useful" and the like, is inevitably a Bayesian task. It is fair to say that in the human logic of reasoning under uncertainty, probability theory (and thus Bayes' theorem) is the only candidate (we would not draw balls from an urn, and make inferences about its contents, on any formal understanding other than the laws of probability).

Frequentist or "classical" statistics, which we have probably all studied, refuses to play that game. It is not permitted under frequentist statistical theory to put a probability of any description on a proposition or "hypothesis". We can write $f(data|hypothesis)$, provided that we interpret f as frequency, but we cannot write $f(hypothesis|data)$ on any interpretation of f. So, for example, we cannot use accounting data to come to an assessed probability of a firm going bankrupt, which of course means that we cannot revise that probability when new accounting data arrives.

Subjectivist Bayesian inference supports inferences drawn from accounting "measurements" or "numbers" and does not need input observations/signals to have any substantive meaning other than as merely a "signal". Just as we can use a barometer to give an "indicator" of what weather to expect, while not necessarily giving that reading of barometric pressure any deeper scientific interpretation, Bayesian theory shows that extensibly "meaning-free" or merely "hard to interpret" accounting disclosures (and non-disclosures) can be decision-useful indicators of economic fundamentals. That understanding of Bayesian belief revision and decision-making was brought to accounting theory by Feltham, Demski and others in the 1960s and 1970s, and mirrored the rise of neo-Bayesianism in other fields in the 1950s–1960s, which in

turn followed a burst of statistical work in decision theory, operations research and code breaking during WWII.

The approach taken in this monograph is a Demski-like treatment of "accounting numbers" as "signals" rather than as "measurements". It should be of course that "good" measurements like "quality earnings" reports make generally better signals. However, to be useful for decision-making under uncertainty, accounting measurements need to have more than established accounting measurement virtues, of the types that early theorists like Paton, Bell and Sterling might have advocated, and which recently resurfaced in the 1960s/1970s-like normative discussion in Hodder *et al.* (2014) and Dechow *et al.* (2010). Chen and Schipper's view is that accounting measurements need to possess enough technical Bayesian information attributes to materially influence users' beliefs and consequent investments. This monograph is really about explaining what those Bayesian information attributes are, where they come from in Bayesian theory, and how they apply in statistical accounting information theory.

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