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An Interdisciplinary Journey with Professor Yuji Ijiri

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Abstract:

Professor Yuji Ijiri is an interdisciplinary scholar. This essay is a recollection of some of his interdisciplinary works during the later period of his academic career.

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2. "Axioms and Structures of Conventional Accounting Measurement" by Yuji Ijiri, <https://doi.org/10.1515/ael-2017-0057>
3. "Yuji Ijiri: Accounting for a Better Society" by Shyam Sunder, <https://doi.org/10.1515/ael-2017-0045>
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"Logic will get you from A to B. Imagination will take you everywhere."

—Albert Einstein

It is a great honor to have this opportunity to celebrate Professor Ijiri. It is hard to believe that he is no longer with us. He was the reason I applied to the doctoral program at Carnegie Mellon University. In 1996 when I was still in China I first read his work on triple-entry bookkeeping (Ijiri 1982; 1984) which opened my eyes to a new world of accounting research that is based on mathematical reasoning and logic. Two years later, I was admitted to the doctoral program at Graduate School of Industrial Administration (GSIA), Carnegie Mellon University, which turned out to be the best place for me to pursue graduate study. Towards the end of my doctoral study and at the start of my academic career, I was very fortunate to work with Professor Ijiri on a few projects. Through these projects, Professor Ijiri led me to search in other academic disciplines to solve accounting problems. As I recall, I was constantly in awe (and still am) of Professor Ijiri's ambition, imagination, and genius in pursuit of scholarship—always looking for new ways to understand accounting.

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1 Symmetric accounting and domain stretching

In our first paper we worked on the issue of how to properly measure and control environmental bads (such as hazardous waste) as opposed to simply being reactive to penalty charges (Ijiri & Lin, 2006). Conventional accounting, mapping the commodity space that only contains positive resources (goods) to financial statements, is asymmetric. Setting aside equities, assets are the positive flows including present goods and future goods to receive; liabilities are negative flows including only future goods to deliver. There is no present negative flow. In an economy in which disposal of hazardous wastes (bads) is material, environmental accounting can be developed by adapting the conventional accounting framework: present bads in stock and future bads to receive are negative flows and future bads to deliver are positive flows. Such constructs are logically sound as they are consistent with the axiomatic structure of measurement developed by Professor Ijiri in 1965. That is, by adding time dimension every object should be defined as present, future incoming and future outgoing. However, environmental accounting alone is flawed because there is no counterpart of cash in environmental accounting; an entity cannot survive with only bads.

As illustrated in Figure 1, conventional accounting (the top unshaded portion) and environmental accounting (the bottom shaded portion) can be seamlessly connected and integrated. There are three positive flows (present goods, future goods to receive and future bads to deliver) and three negative flows (future goods to deliver, present bads and future bads to receive), constitute a perfectly symmetric presentation. Symmetric accounting maps the commodity space that contains both goods and bads to financial statements. It is forward-looking, and helps proactively control environmental bads.

Positive Flows	Negative Flows
Present goods	Future goods to deliver
Future goods to receive	Present bads
Future bads to deliver	Future bads to receive

Figure 1: Integrating conventional and environmental accounting.

The construct of symmetric accounting is analogous to “domain stretching” in mathematics—extension takes place by expanding the domain of interpretation without changing the original (more limited) region (Derbyshire, 2003). To see this, consider two functions S and R .

$$S(x) = 1 + x + x^2 + x^3 + \dots \text{ for } x \in (-1, +1)$$

$$R(x) = 1/(1-x) \text{ for } x \in (-\infty, 1) \cup (1, +\infty)$$

Function S converges to R in the open interval $(-1, +1)$; outside of this interval S diverges and is not well-defined. Since R has values for all numbers except $x = 1$, the domain of S is larger than the interval $(-1, +1)$. We say the domain of function S is stretched by R . The domain of conventional accounting includes only goods. Symmetric accounting stretches its domain to include bads. The accounting for goods under symmetric accounting remains intact.

2 Topological accounting and quantum information

Accounting and quantum physics both are information science. Learning quantum information may help enhance our understanding of accounting information. I am greatly indebted to Professor Ijiri for giving me the opportunity and courage to be part of the two projects, Demski, FitzGerald, Ijiri, Ijiri, and Lin (2006) and Demski, FitzGerald, Ijiri, Ijiri, and Lin (2009), conducted jointly with Professor Joel Demski, and two physicists—Professor Yumi Ijiri and Professor Stephen FitzGerald. These projects reflect our efforts for connections between accounting information and quantum information. I gained first-hand experience of interdisciplinary research. It requires reasoning to integrate knowledge from different disciplines. As Professor Ijiri said, “Interdisciplinary reasoning forces people to focus on bigger pictures across disciplines and create a new understanding of the phenomena at a higher level.” (Ijiri, 2004).

The concept of topological accounting, suggesting applications of topology to accounting, was developed only after the authors learned topological quantum computation (Demski et al., 2009). To illustrate, suppose we throw a ball upwards. Its trajectory can be accurately traced and recorded. Suppose we throw 100 balls simultaneously. Because the balls interact with each other, the task of tracking each ball quickly becomes impossible. Treat a collection of balls going up and coming down as a cloud of balls. Topology focuses on the patterns that the cloud of balls creates, not the movement of any individual ball. Topology studies (global) properties of shapes and partitions all shapes into different classes with topological equivalence. The word “global” can be supported with the following three features. One, the properties of shapes do not depend on the shapes’ positions—coordinate invariant. Two, the properties do not change due to smooth deformation. A circle, an ellipse and an oval are all topologically equivalent. Three, the topological properties ignore finer details so that compressed representations of shapes can be constructed. For example, a hexagon can represent a circle if we ignore the curvature of the arc.

We asked: Can we identify topological properties of accounting information that (i) are coordinate invariant, (ii) are deformation invariant, and (iii) downplay the role of finer details? Sometimes, one does not need precise information, but only approximately correct information. Our long-standing notion of materiality comes to mind. Abstractly it is a norm, but can we possibly use it to parameterize an accounting-based topological space?

We speculated how topological accounting may be applied (Demski et al., 2009). The first possible application is to accounting standards. Topology is inherently a classification system. Classifying is a basic function in accounting. With more complex transactions and tremendous growth in instruments, a much richer classification scheme may be in order (the fair value hierarchy is an example of this). Not only vocabularies but also the logic and structure of concepts can be supplied by topology to make them consistent and efficient in developing accounting standards. The second possible application is to forecasting. Information based on forecasts (as opposed to facts) is subjective and error-prone. One way to protect information users is to focus on topological properties of information as it offers a means to ignore the finer details. Forecasted information with fewer finer details may be less subjective.

The third possible application is to internal control and auditing. Topology is built on the notion of connectivity; and double-entry accounting is also built on accounts and connectivity among accounts. Section 404 of the Sarbanes-Oxley Act requires attestation by a public accounting firm about the management assessment of the internal control (similar provisions were introduced by Dodd-Frank Act for financial institutions after the 2008 global financial crisis). Internal control means control of the entire operations as a whole as far as the information flow is concerned. From an auditor’s perspective, this “big picture” orientation is very much in line with topology in the sense that one is not interested in tracking each account per se, but instead interested in their connectivity and broader features.

What’s proposed here is to take a dual perspective, conventional and topological. The topological perspective is more macro-oriented. The background, or circumstances surrounding the events, may show more intriguing patterns than the individual event in the “foreground”. The topological perspective focuses on qualitative characteristics without compromising mathematical rigor.

As physicists claim, from quantum computation to topological quantum computation is a paradigm shift. Are accounting thoughts ripe for a paradigm shift? Borrowing from one of Professor Ijiri’s favorite quotes by a physicist Andrew Steane (1998), “a more lasting reason to be excited about [topological accounting] is that it is a new and insightful way to think about the fundamental laws of [accounting].”¹

To me, Professor Ijiri has always been a mentor, an inspiration, and a model of scholar. Because of him, I was able to explore “quantum physics” which I would not have had the courage to try on my own. Because of him, I coauthored with two brilliant physicists—Yumi and Stephen—that I could never dream of doing². Setting examples by doing it himself, what Professor Ijiri taught me in the journey will be forever treasured. For that I owe him my deepest gratitude.

For many, Professor Ijiri was the gardener of the “accounting garden” at GSIA; he always nurtured and protected his students. Indeed, he was gentle, caring, and always approachable. He once shared with me good parenting tricks. He said, praising good behavior is just as effective as criticizing bad behavior; like the dualistic aspects of double-entry accounting, although it is more difficult to restrain from criticizing bad behaviors. A few years later I was able to put the trick to test; it worked and still works. Professor Ijiri, we miss you.

Notes

1 The original quote is from Steane (1998, p.40), “A more lasting reason to be excited about quantum computing is that it is a new and insightful way to think about the fundamental laws of physics.”

2 2: Yumi and Steven are Professor Ijiri’s daughter and son-in-law.

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