

History and Bookkeeping

Theory Session #1

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Accounting History

History: Before double entry

- 8500 BCE: Shaped clay tokens represent commodities
- 200 BCE: Arabic numerals (except 0)
- 600 CE: 0 developed
- 800 CE: 10-digit numerals spread throughout Europe



MS 4631

Bulla-envelope with 11 plain and complex tokens inside
Near East, ca. 3700-3200 BC

<http://www.schoyencollection.com/mathematics-collection/pre-literate-counting/bulla-envelope-ms-4631>

*Note: This slide is based on a history lecture by Dr. Pierre Liang at Carnegie Mellon from October 2017

History: Double entry

- 1400s CE: First evidence of *double entry* bookkeeping in Italy
- 1494 CE Italian monk and scholar Luca Pacioli publishes first text on *double entry* bookkeeping
 - Summa de Arithmetica, Geometria, Proportioni et Propotionalita



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History: Journal entries

(1491)

7. *Faro debetore* Tomasone del Buono e *creditors* spese di mercanzie di s. iiii d'oro per spese fatta a un fardello di panno corsato mandato da Lucca da Bonaccorsi a Libro 203/100 lib—siiiij d—

7. *I make debtor* Tomaso del Buono and *creditor* Merchandise Expenses for 4 s. in gold, for expenses incurred on a bale of cloth sent by Lucca da Bonaccorsi in the book 203/100 lib. —s4d—

(1553)

10. Devonshire Kerseys is debtor to Laurance Fabian, draper, and is for 10 pieces at 36 s. a piece—etc.—L. 108 s—d—

(1570)

14. Roggen *soll an* Hering, hab ich mit Andreas Klur von Thorn einen stick getroffen—etc. fl. 472.15—

14. Rye *owes to* Herring, which I have bartered with Andreas Klur of Thorn—etc...fl. 472.15

(1595)

11. Cassa van ghereden ghelde is *schuldich aen* Cappital van my 8000 guld. Ende is voor verscheyden panninghen van gout ende silver, so ick in mynen handen hebbe, omme daermede te dryuen den handel van coopmanchap. Godt wil my verleenen ghewin, ende behaeden voor verlies. Amen...g. 8000

11. Ready money is *indebted to* Capital for my 8000 guilders. And is for different coins of gold and silver that I have in hand to use in pursuing the trade of merchandise. God will grant me profit and preserve me from loss. Amen...g. 8000

Images from Littleton 1928 TAR.

History: Journal entry evolution

(8)			
<i>English Journal Entries After 1600</i>			
	(1684)		
19.	George Pinchback Debitor to Kettles £75-8d for 5 barrels—etc.	75/-/8	
	(1717)		
20.	P. Q. at Gibraltar my accompt current Debtor to Voyage to Gibraltar, consigned to P. Q. £322.9.7½—etc.....	322/9/7½	
	(1754)		
21.	William Wife £360 to Sherry for 10 pipes delivered to him in barter.....	360/-/-	
	(1788)		
22.	Charges merchandise Dr. to paper taken for use in shop.....	-/10/6	
	(1841)		
23.	Dr. Mdse. 1000	Cr. B/P 500 Cash 500	
	(1848)		
24.	Cash to Sundries to Bills Receivable Profit and Loss	1590 " 1500 " 90	
	(1864)		
25.	Merchandise Dr. to James Munroe	Dr. 5000 " 5000	Cr.
	(1900)		
26.	Merchandise to Cash	400	400

Shakespeare likely did this sort of work for the British Navy! (Source: [Reynolds 1974 JAR](#))

A note on journal entries

1. Journal entries \neq Double entry
 - You can create a single entry journal entry
 - Or a triple entry!
2. Journal entries are not needed for double entry to function
 - Littleton (1928) makes this point, arguing that ledgers are sufficient, so long as adjustments to ledgers follow the principles of double entry

Modern history of bookkeeping

- 1845 CE: Business corporation law passed in England
- 1887 CE: AAPA founded (Predecessor to AICPA)
 - American Association of Public Accountants
- 1904 CE: ACCA founded in London
- 1934 CE: Securities Exchange Act establishes the SEC, mandates audits
- 1940 CE: Paton and Little monograph published
 - A serious discussion of *accounting standards*, rather than principles
- 1973 CE: FASB replaces the APB

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History: Impact

The Principles of Book-keeping by Double Entry constitute a theory which is mathematically by no means uninteresting: it is in fact like Euclid's theory of ratios an absolutely perfect one, and it is only its extreme simplicity which prevents it from being as interesting as it would otherwise be.

– Arthur Cayley, FRS, *The Principles of Book-keeping by Double Entry*, 1894.

Bookkeeping has become a real technology instead of a simple clerical routine, and in addition there has grown up a profession of accounting which reaches quite beyond bookkeeping.

– A. C. Littleton, *The Evolution of the Journal Entry*, 1928.

Why do we care about *bookkeeping*?

1. Without bookkeeping, what would be left of accounting?
2. Why does so little research focus on bookkeeping?
3. What could we do if we had access to companies' bookkeeping records?
4. What does our lack of such records mean for our discipline?

Why do we care about *bookkeeping*?

- From Hatfield (1924), bookkeeping is respectable in at least three ways:
 1. Lineage
 2. Respectability of those that studied accounting
 3. Services provided to society

The Lineage of bookkeeping

- Double entry, as we generally think of it, was formalized in a chapter of Luca Pacioli's *Summa*, as a section titled *De Computis et Scripturis*
 - Pacioli was:
 - A well respected Italian mathematician
 - A coauthor of Leonardo Da Vinci
 - *Summa* stood as the authority on bookkeeping for >100 years

“Let those who vaunt the superior merits of other disciplines remember that this first presentation made by Paciolo was not crude and incorrect but contains the essentials of bookkeeping as we know it today, despite the fact that it was written at a time when chemistry partook of the vagaries of alchemy, biology was a weird collection of errors, and medicine had more in common with the medicine man than it has even today.”

Those that studied accounting historically

- Luca Pacioli: Well respected mathematician
- Henricus Grammateus: Mathematician, first to publish on bookkeeping in German
- Jerome Cardan: Polymath
 - “astrologer, physician, scientist, mathematician, professor of medicine”
- Before 1800, writers on bookkeeping included authorities on:
 - Algebra, navigation, optics, foreign exchange, author of the *Code Savary*, astronomy, grammar, gunpowder, history
 - Four members of the Royal Society
- After 1800:
 - Augustus De Morgan: De Morgan’s laws (e.g., $\overline{A \cup B} = \overline{A} \cap \overline{B}$)
 - Arthur Cayley: Renowned mathematician

Service to society

- That bookkeeping exists is not by chance
- “Bookkeeping arose as a direct result of the establishment of partnerships on a large scale, a feature of expanding commerce” (Sieiveking, in Hatfield 1924)
- The expansion of trusts (precursor to corporations in present society) led to an explosion in demand for bookkeeping
 - The “billion dollar corporation”

Expansion of bookkeeping?

- What about present society, with the “trillion dollar corporation?”

If the substitution of a small partnership for the individual trader called for improvement in bookkeeping methods, how much more was improvement needed when the partnership was displaced by the corporation with its owners numbered by the tens of thousands?

The use of fixed capital on a large scale increases incalculably the difficulty of determining the profits earned in any given year.

The background of the slide is a dark blue gradient with a network diagram. The diagram consists of numerous white circular nodes of varying sizes, connected by thin white lines. Some nodes are larger and more prominent, while others are smaller and less visible. The connections form a complex web of lines across the entire slide.

Where are we at?

In 1924

- Hatfield (1924) argues that there were two primary areas of progress:
 1. Methods of handling large quantities of calculations
 2. An “attempt to ascertain the exact cost of producing objects or parts of objects”

In 2007

- Fellingham (2007), “Is Accounting an Academic Discipline?”
 - Disconnect between teaching and research
 - We emphasize standards instead of our “best ideas” – emphasize the *vocational*
 - Heavy focus on clinical faculty
 - Revelation of DBA programs
 - Focus on rankings rather than academics in teaching
 - Focus on revenue generation at universities
 - Progress on the “science of information”
 - Accounting as an information science?

Also In 2007

- Demski (2007), “Is Accounting an Academic Discipline?”
 - *No*, “the vocational focus is overwhelming”
 - “Innovation is close to nonexistent”
 - Something like the ratcheting effect at work
 - Laments the lack of information science in our curriculum
 - “Double entry, in fact, is a primitive error-detecting code”

Demski's characterization of accounting research

“Accounting per se has disappeared from our activities. Likelihood structures or random variables routinely substitute for accounting structure. Simple models of accruals, as opposed to sophisticated, economic-based structural models, based on accounting structure and economic fundamentals, are routinely employed in our research and teaching. And most telling, choices in accounting measurements are routinely ignored, such as the choice to nudge EPS or to forecast at a specific time and with a specific amount. Indeed, virtually no issue in accounting would exist were it not for management's choice behavior, though this is treated as largely second order in the vast bulk of our teaching and research.”

How to get back to our academic roots?

- “[Accounting] could and should [...] be an academic discipline”
- What is missing? **Passion**
- “Our responsibility is not to prosper in this culture or to do well; it is to do good.”
- “At this point, the only path I see is mutiny. It is time to strike out, to change the game, to ensure accounting has an honorable presence in the academy.”
 - “Don’t play the game. Redefine the game.”

What is Accounting Theory

Based on Liang (2010), “An Invitation to Theory”

What is theory?

“Theory is a coherent set of ideas that explains, or purports to explain, a set of real-world phenomena.”

- Coherence need not be at the surface level

“A theory offers a consistent, disciplined way to view the world, or a worldview”

Foundations

1. Mathematics

- Bookkeeping
- Mathematical elegance of accounting structures

2. Economics

- Neo-classical measurement
- Information economics and frictions

3. Psychology

- Biases at the individual or organizational level
- Behavioral economics/finance

How does theory help guide empirics?

1. Identifying research questions

- Economic research informs us of trade-offs
- Such trade-offs can suggest research questions

2. Developing hypotheses

- Theory can predict *direction* and *magnitude* of effects

3. Designing and conducting tests

- Theory can point to sources of endogeneity

4. Interpreting findings

- Theory can provide testable predictions, and thus frame a discussion
- Theory can help organize thoughts/perspectives

Where are we at, revisited

- Measurement perspective
 - Focus on valuation: How to [more accurately] measure something
 - Relevant to practice
 - Caveat: seemingly less likely to be academically relevant
- Information perspective
 - Focus on identifying and providing information that is decision relevant
 - Generally winning out over recent decades
 - Caveat: “Information” provides a superstructure but lacks a solid foundation
 - In contrast: Bookkeeping provides a solid foundation but no superstructure

Inferring bookkeeping activities

Arya, Fellingham and Schroeder (2000, IEA)

Overview

- Inverting Exercise
 - Transactions \rightleftharpoons Financial statements
- Aggregation
 - Information of economic activities
 - Numbers under account balances
 - **Directed graph representation** of the accounting system
 - Characterization of all consistent transaction vectors
- Estimation Problem
 - Picking the most likely transaction vector (based on priors and financial statements)

The inverting exercise

Seven transactions (accounting events)

1. Purchase of raw materials inventory for cash
2. Plant and administrative buildings acquired for cash
3. Cash (period) expenses
4. Cash sales
5. Cost of goods sold
6. Product cost depreciation
7. Period cost depreciation

Balance Sheet

Cash	2	10
Inventory	4	0
Net plant & buildings	6	0
Owners' Equity	12	10

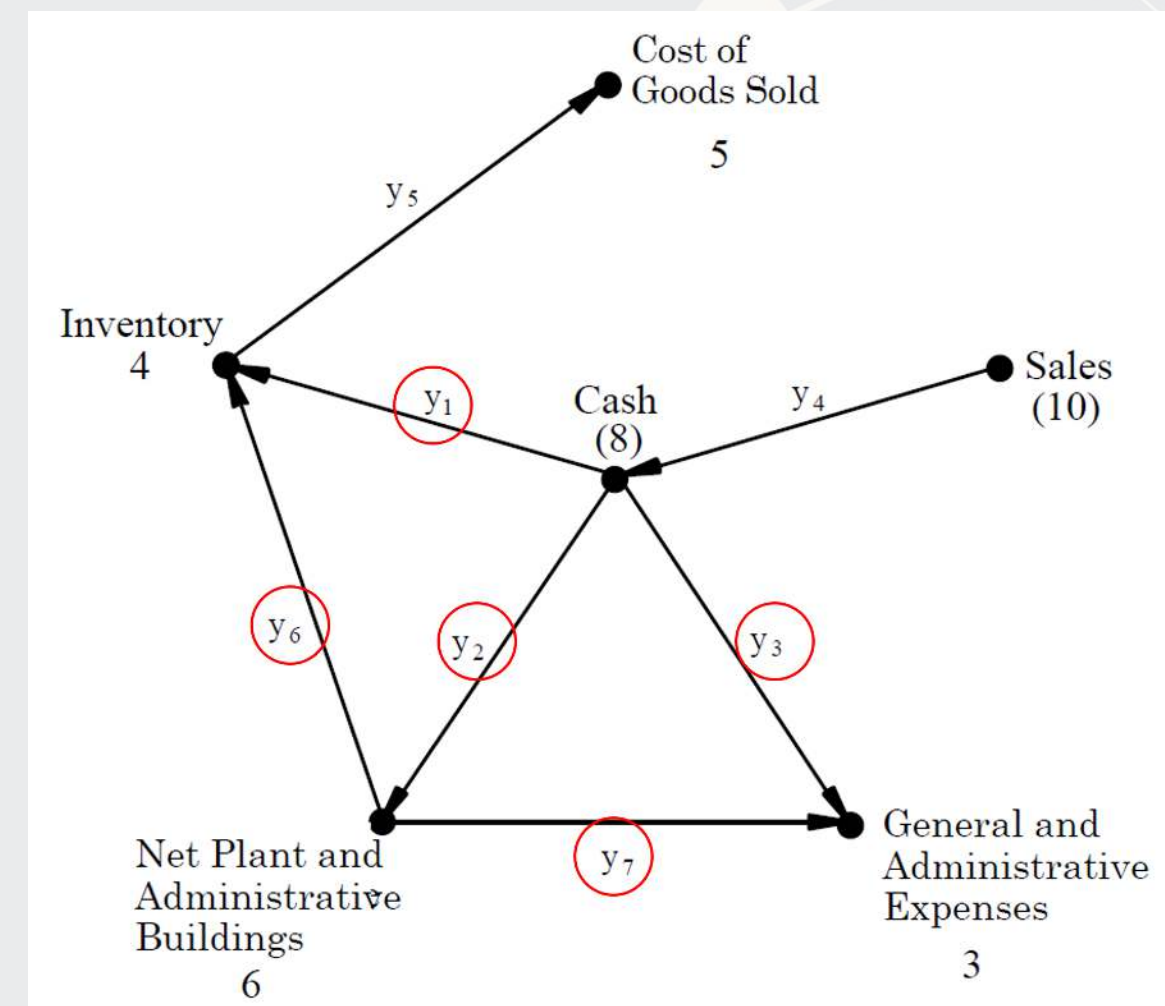
Income Statement

Sales	10
Cost of goods sold	5
General and admin exp.	3
Income	2

The directed graph representation of accounting system

Seven transactions (accounting events)

1. Purchase of **raw materials** inventory for **cash**
2. Plant and administrative **buildings** acquired for **cash**
3. **Cash** (period) **expenses**
4. Cash sales
5. Cost of goods sold
6. **Product cost** depreciation
7. **Period cost** depreciation



Characterization of all “consistent” transaction vectors

The Output Spreadsheet

	A	B	C	D	E	F	G	H	I	J	K	
1		A matrix							Variable (y)			
2	Cash	-1	-1	-1	1	0	0	0			8	
3	Inventory	1	0	0	0	-1	1	0			9	
4	Net Plant	0	1	0	0	0	-1	-1			1	
5	Sales	0	0	0	-1	0	0	0			10	
6	CGS	0	0	0	0	1	0	0			5	
7	G & A Exp	0	0	1	0	0	0	1			1	
8											2	
9												
10												
11	Constraint											
12		LHS (Ay)			RHS (Δx)							
13		-8			-8							
14		4			4							
15		6			6							
16		-10			-10							
17		5			5							
18		3			3							

$$\begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \\ y_5 \\ y_6 \\ y_7 \end{bmatrix} = \begin{bmatrix} 8 \\ 9 \\ 1 \\ 10 \\ 5 \\ 1 \\ 2 \end{bmatrix} + k_1 \begin{bmatrix} -1 \\ 1 \\ 0 \\ 0 \\ 0 \\ 1 \\ 0 \end{bmatrix} + k_2 \begin{bmatrix} 0 \\ 1 \\ -1 \\ 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

The estimation problem

$$y = (I - P)y^p + P\bar{y}$$

y : the best guess $\left\{ \begin{array}{l} (1) \text{ consistent with } \Delta x \text{ and} \\ (2) \text{ most likely, i.e. the posterior mean} \end{array} \right.$

P : projection matrix, $P = N(N^T N)^{-1} N^T$

\bar{y} : the prior mean

Two assumptions

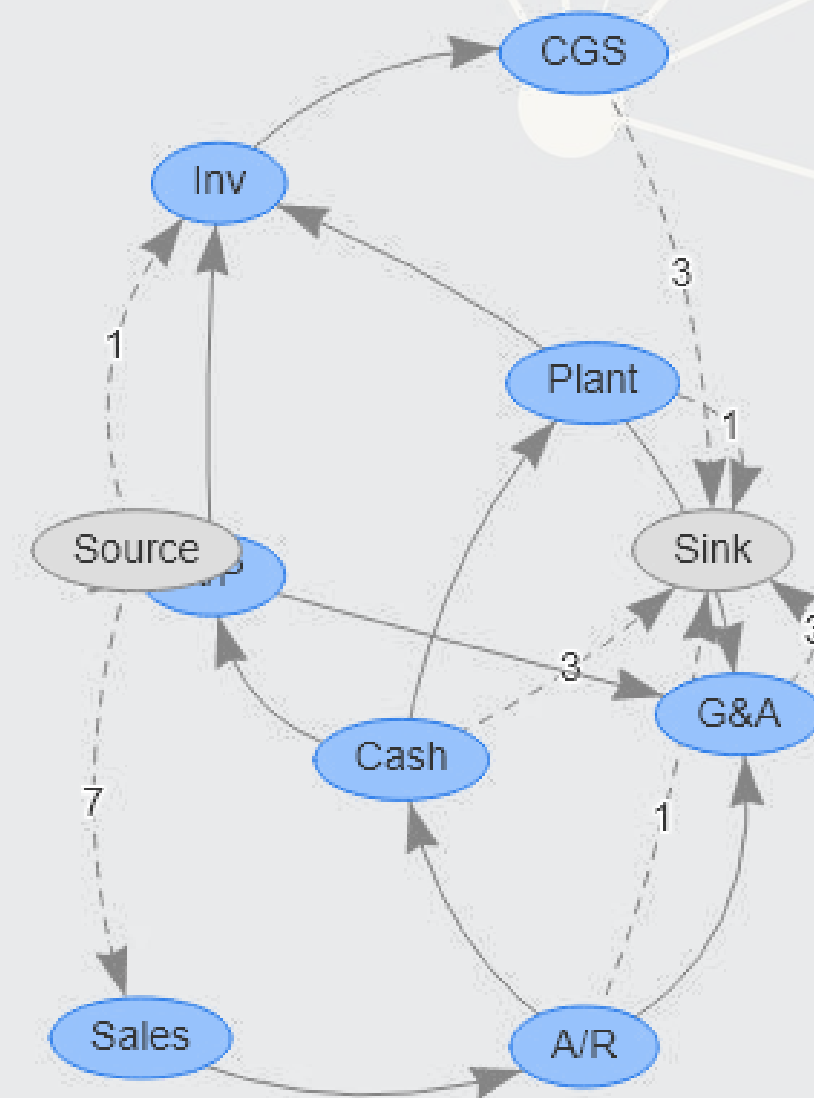
1. The choice of which transactions to model
2. Transactions have identity variance-covariance structure

Inferring bookkeeping activities

Arya, Fellingham, Mittendorf and Schroeder (2004, CAR)

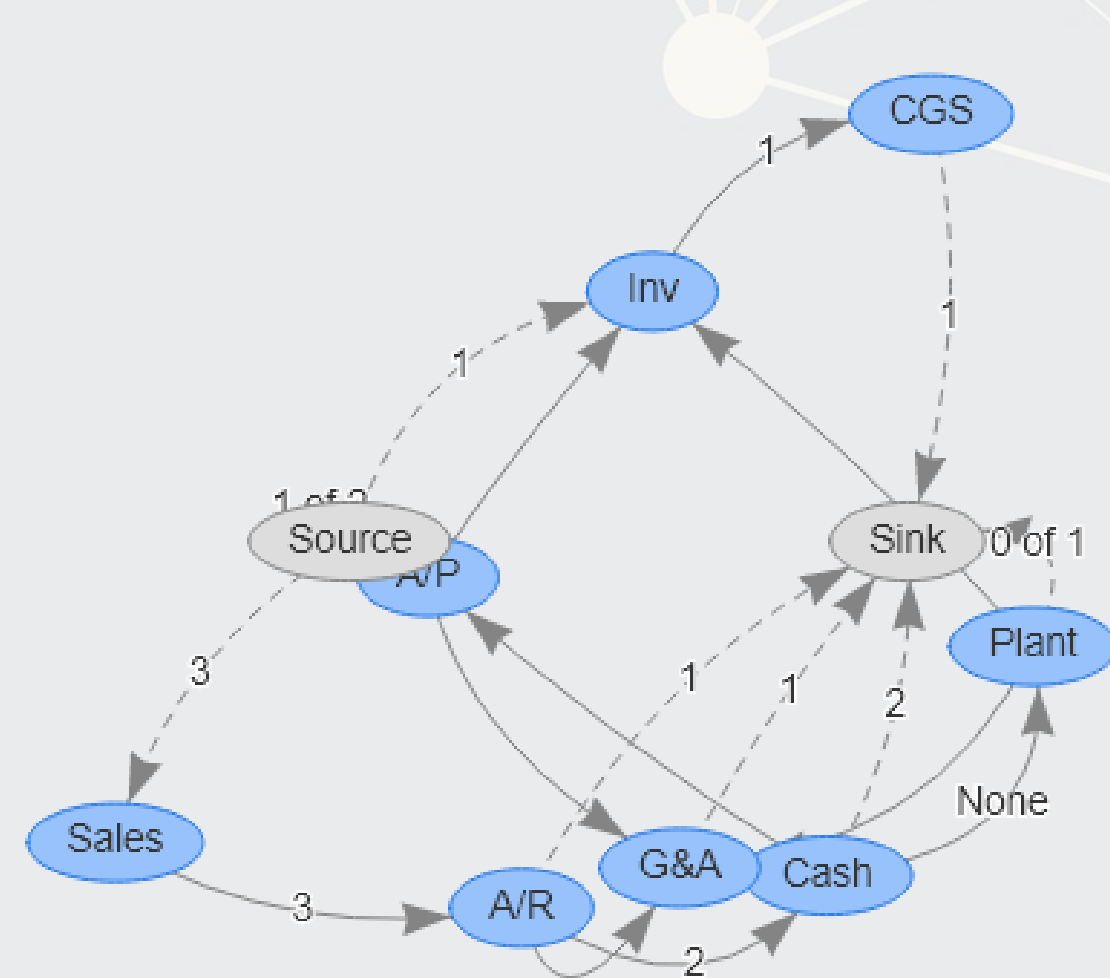
Understanding the directed graphs

- Source
 - sets credit values
- Sink
 - sets debit values
- Nodes
 - Accounts
 - Δ for B/S
 - level for I/S
- Edges
 - Transaction classes
- *flow*
 - Tracing out a path for consistency



Application: Audit

- Run analysis on directed graph
 - Issue: need to make the graph/possible transaction set first
- Can help to pinpoint where to look for problems
 - *Caveat*: but only if the statements are not consistent
 - *Benefit*: If not consistent, you have a good idea of where to look

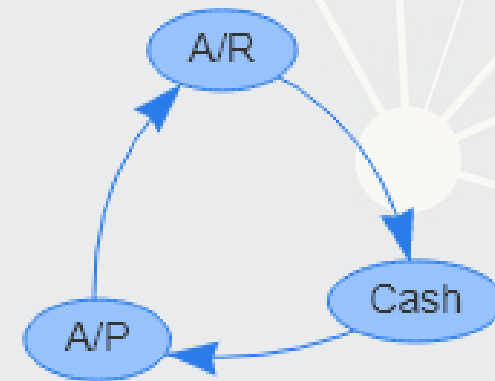


Thoughts on Audit use

- Unlikely to detect intentional misreporting
 - Such misreporting is largely in line with other transactions
- Could help with detecting transactions to the wrong accounts
 - This can also be done by checking the journal entries...

Application: Ratio analysis

- Can determine bounds on ratios
- *Caveat*: no boundary if there is a negative loop



Example from the paper: Payables Turnover

- Typically substitute $CGS + \Delta Inv$ for **inventory purchases on credit**

- $$\frac{CGS_t + \Delta Inv_t}{(A/P_{t-1} + A/P_t)/2} = \frac{2}{8.5} = 0.24$$

- Adjusted: $\frac{[0,2]}{8.5} = [0, 0.24]$



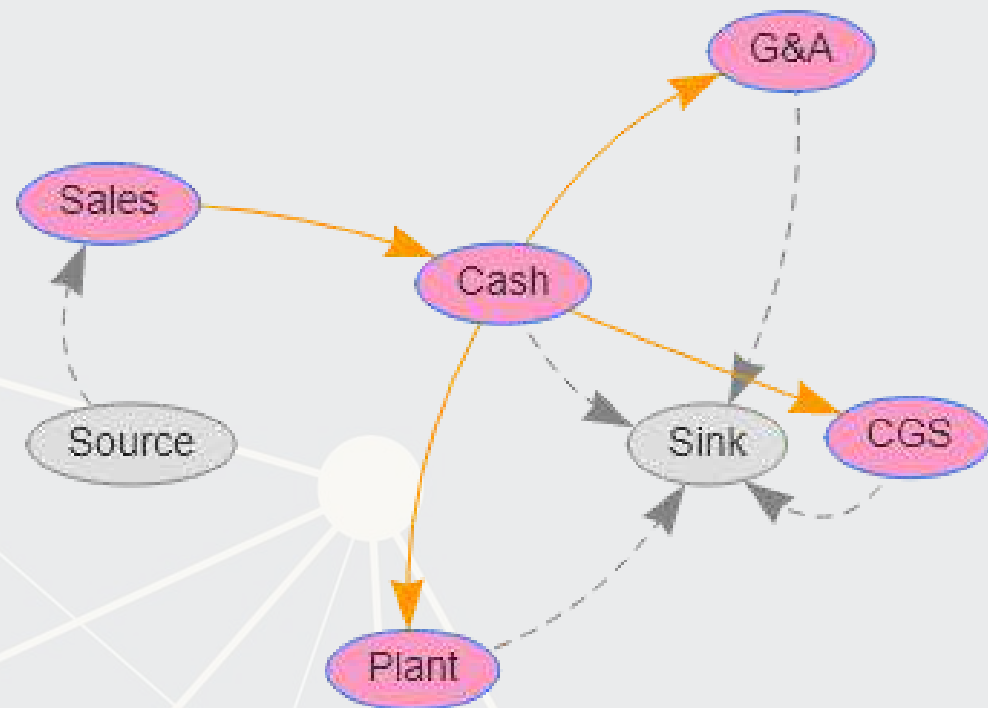
Discussion

Representations

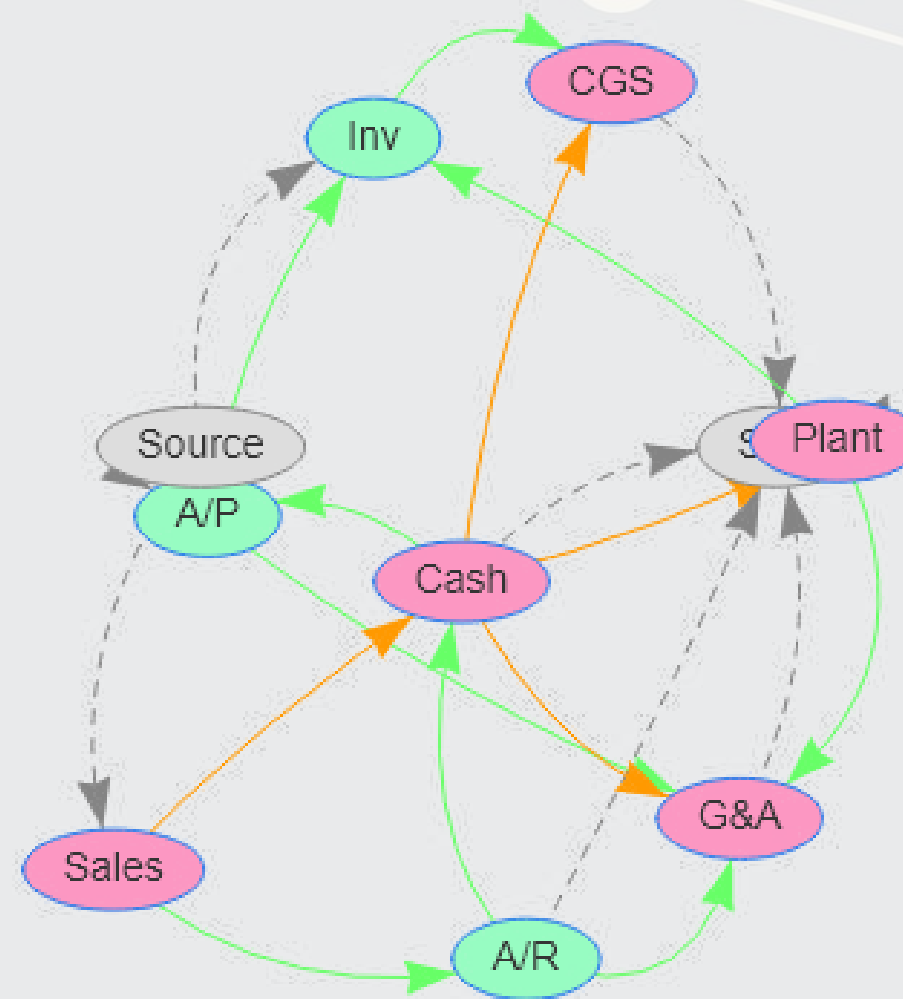
1. Are there any other sensible representations of double entry bookkeeping?
2. What parts of the current system give rise to a directed graph?
3. Accruals? Double entry?

Representations

Cash basis



Accrual basis additions



Aggregation

1. How much aggregation is optimal? Tension between complexity and usefulness
2. What about providing both aggregated and disaggregated information?
3. What would an economy look like if only disaggregated information was made available?

Aggregation is central to these papers – without aggregation, we would already know the transactions.

Appendix

References

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Packages used for these slides

- knitr
- revealjs
- visNetwork