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THE STATE UNIVERSITY OF NEW JERSEY

The CarLab

Continuous Audit and Reporting Laboratory

–Graduate School of Management
–Rutgers University

Visit by the Asian Development Bank
April 22, 2019

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BRIGHAM YOUNG UNIVERSITY

The Ranking of Rutgers in the Accounting Areas

Areas	Ranking 2008-2013	Ranking 2002-2013	Ranking 1990-2013
AIS	#1 out of 179	#1 out of 207	#1 out of 241
Audit	#6 out of 320	#7 out of 370	#11 out of 438
Financial	#70 out of 356	#89 out of 406	#83 out of 470
Managerial	#120 out of 286	#80 out of 346	#66 out of 413
Tax	#53 out of 129	#76 out of 178	#79 out of 246
Other	#35 out of 171	#18 out of 248	#25 out of 341

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CarLab Analytic Research

Choosing apps	Predictive Analytics with Weather data	Audit data analytics and EDA	Envisaging the future of audit and Big Data	Text Mining	Monitoring Unibanco's branches
Visualization	Process Mining at Gamma Bank	Expert System for P-Card	Logit regression for control risk assessment	Exceptional Exceptions	Client Retention Project
Litigation prediction	Fraud Risk Assessment using EDA	Detecting duplicate records	Continuity equations	Predictive Audit	Credit card Default prediction
Insurance Analytics	Multidimensional clustering for fraud detection	Rule-based selection for transitory accounts	Continuity Equations at HCA	XBRL	Insurance Analytics
Cognitive Decision Aids	AI: Deep Learning	Robotic Process Automation (RPA)	Intelligent Process Automation (IPA)	Blockchain and Smart contracts	Cluster Analysis of US States

RUTGERS Digital Library

Content

- **Undergraduate, Graduate, PhD, & Audit Analytics Content**

Undergraduate	Graduate	PhD	Audit Analytics Certificate
• Introduction to Financial Accounting • Introduction to Managerial Accounting • Intermediate Accounting I • Intermediate Accounting II • Advanced Accounting • Auditing Principles • Management and Cost Accounting • Accounting Information Systems • Business Law I • Business Law II • Federal Taxation I • Accounting in the Digital Era • Computer Augmented Accounting • Decoding of Corporate Financial Communications	• Accounting Principles and Practices • Information Technology • Government and Not-for-Profit Accounting • Advanced Auditing and Information Systems • Advanced Accounting • Corporate Taxation • Income Taxation • Income Tax Estate and Trust	• Special Topics in Accounting • Survey of Accounting Information Systems • Current Topics in Auditing • Machine Learning	• Introduction to Audit Analytics • Special Topics in Audit Analytics • Information Risk Management • Tutorials for Risk Management

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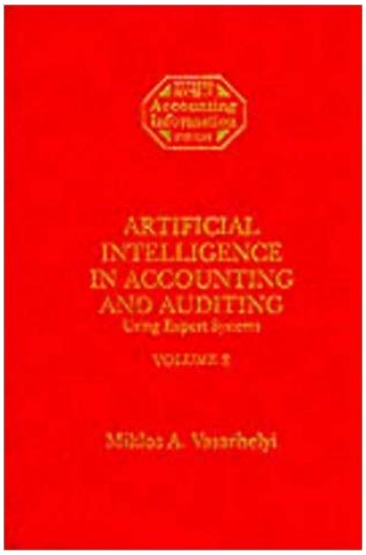

6 volumes

1989 to 2006

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Accounting Estimates Using Machine Learning

Keshing Ding, SWUFE
Baruch Lev, NYU
Xuan Peng, SWUFE
Miklos A. Vasarhelyi, Rutgers University

November 21, 2019 Toronto

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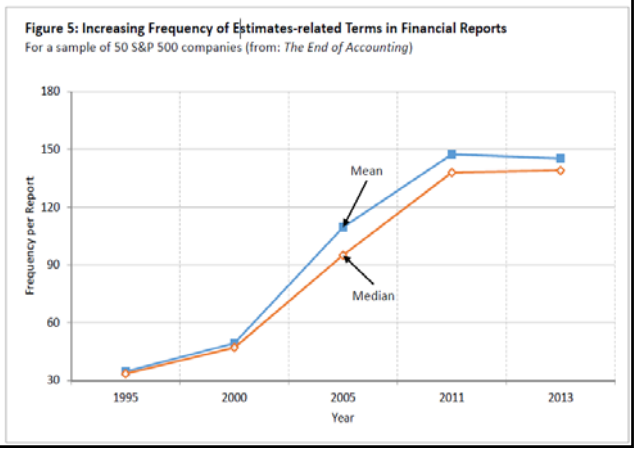
Accounting estimates

"Accounting estimates are pervasive in financial statements, often substantially affecting a company's financial position and results of operations… " (PCAOB 2018, p.3).

Accounting estimate examples:

- fixed assets
- accounts receivable
- pension expenses and incomes



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Self selection and potential bias

- Accounting numbers prior to the fair value had some lenience that allowed some income management
- When flexibility was exhausted they resorted to a “big bath”
- Fair value came in and gave much flexibility to estimates
- Not necessary to resort to major readjustment
- The FASB should resort to some narrow guidelines on method of estimation to limit self serving estimates

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Accounting estimates

- General Electric Example
  - 2016 net earnings is $8.2 billions.
  - Half came from a change in managers’ estimates.

“Contract assets increased $4,006 million in 2016, which was primarily driven by a change in estimated profitability within our long-term product service agreements …”

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Improve estimates

- Causes of estimation errors
  - environment uncertainty
  - managers' manipulation
- Machine learning
  - decreases manipulation: an independent, less-bias estimates generator
  - decreases uncertainty: take into account more factors in prediction
- Our Research
  - use machine learning algorithms to estimate losses for property & casualty insurance companies
  - compare machine learning estimates with managers' estimates

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Data: property & casualty insurance loss estimates

- Insurers receive the revenues (i.e., premiums) before or during the period of coverage, but their full costs —the insurance losses or claims by policyholders —usually remain unknown long after the coverage period ends.

	INCURRED NET LOSSES AND DEFENSE AND COST CONTAINMENT EXPENSES REPORTED AT YEAR END ($000 OMITTED)										DEVELOPMENT	
Years in Which Losses Were Incurred	1	2	3	4	5	6	7	8	9	10	11	12
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	One Year	Two Year
1. Prior												
2. 1999	4,583	4,615	4,614	4,615	4,615	4,617	4,617	4,618	4,618	4,618	1	
3. 2000	XXX	4,382	4,450	4,409	4,407	4,413	4,411	4,419	4,422	4,422		3
4. 2001	XXX	XXX	4,845	4,883	5,012	5,016	4,909	4,904	4,905	4,904	(1)	
5. 2002	XXX	XXX	XXX	7,463	7,270	7,064	7,178	7,169	7,136	7,147	11	(22)
6. 2003	XXX	XXX	XXX	XXX	18,904	18,091	18,033	17,710	17,465	17,479	14	(231)
7. 2004	XXX	XXX	XXX	XXX	XXX	18,201	15,408	15,301	14,754	14,727	(27)	(574)
8. 2005	XXX	XXX	XXX	XXX	XXX	XXX	24,097	20,611	23,627	24,554	927	3,943
9. 2006	XXX	XXX	XXX	XXX	XXX	XXX	XXX	23,828	21,900	21,993	93	(1,835)
10. 2007	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	24,226	24,334	108	XXX
11. 2008	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	36,893	XXX	XXX

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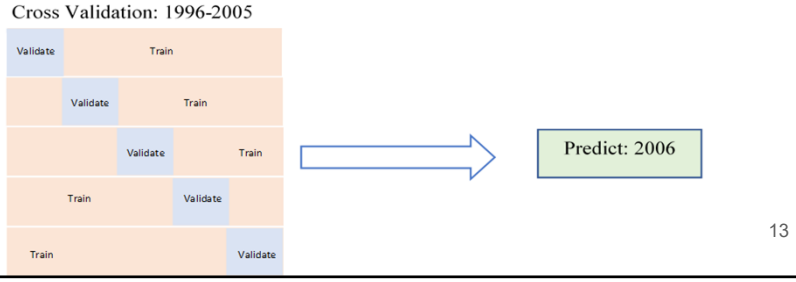
Research design

- Business lines (cumulative payment percentage)

Business Line	Year 0	Year 1	Year 2
Private Passenger Auto Liability	40.64%	72.44%	86.76%
Commercial Auto Liability	25.03%	50.74%	70.90%
Workers' Compensation	24.99%	56.11%	72.90%
Commercial Multi-Peril	44.52%	69.22%	80.03%
Homeonwer/Farmowner	72.62%	93.50%	96.83%

- Training/Validation/Testing approach



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Cross-validation results

- The percent accuracy improvement of the ML loss estimates over managers' estimates in 5-fold cross validation.

Business line	Sample	Obs	Accuracy Edge
Private Passenger Auto Liability	1996-2005	5949	12%
	1996-2006	6298	13%
	1996-2007	6602	26%
Commercial Auto Liability	1996-2005	5383	42%
	1996-2006	5661	36%
	1996-2007	5957	37%
Workers' Compensation	1996-2005	4183	35%
	1996-2006	4398	43%
	1996-2006	4398	48%
Commercial Multi-Peril	1996-2005	5235	33%
	1996-2006	5457	34%
	1996-2007	5846	42%
Homeowner/Farmowner	1996-2005	6121	-12%
	1996-2006	6544	24%
	1996-2007	6946	24%

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Holdout test results

- The percent accuracy improvement of the ML loss estimates over managers' estimates in holdout test.

Business line	Sample	Obs	Accuracy Edge
Private Passenger Auto Liability	2006	670	26%
	2007	659	14%
	2008	637	37%
Commercial Auto Liability	2006	620	20%
	2007	609	20%
	2008	592	49%
Workers' Compensation	2006	499	54%
	2007	498	55%
	2008	473	19%
Commercial Multi-Peril	2006	582	50%
	2007	570	22%
	2008	563	-18%
Homeowner/Farmowner	2006	697	51%
	2007	692	38%
	2008	678	52%

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Conclusion

- Accuracy edge: accounting estimates generated by machine learning are potentially superior to managerial estimates.
- Benchmark: estimates generated by machine learning can be used by managers and auditors as benchmarks against which managers' estimates will be compared. Large deviations will suggest a reexamination of managers' estimates.
- Potential: machine learning could be used to generate estimates to be report in the first place.
  - enhance the reliability (no manipulation) and consistency of accounting estimates.

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The FASB could

- Create a machine learning estimate for a very narrow industry corresponding to reporting lines of business
  - Determine estimate based on an allocated percentage or and adjusted percentage of the business
- Allow businesses to do their computations and estimates with
  - A pre-set estimation methodology with machine learning or the machine learning done by the standard setter
  - The inputs to the estimation methodology (variables) be auditable values

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