# Rethinking Analytical Review

Kexing Ding

Xuan Peng

Yunsen Wang

# Ratio Analysis

"Old" concept:

– Ratio analysis-
an auditing procedure based on ratios among accounts and tries t
o identify significant changes/unusual patterns

"New" thinking:

– Complex business environment - NECESSITY

– Technology advancement – OPPORTUNITY

– Models - CHALLENGE

## Part 1: Financial ratios and peer selection with clustering

We apply machine learning techniques on financial ratios to identify peer firm.

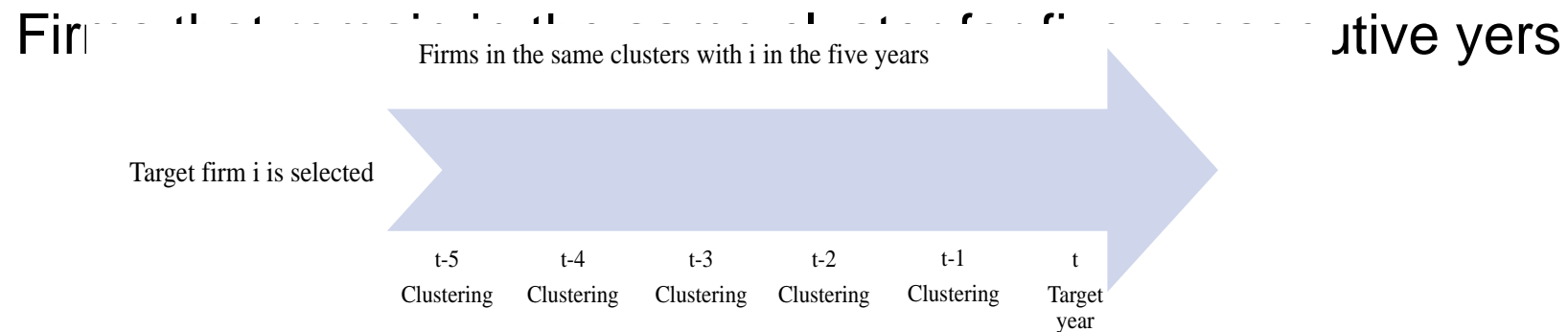Motivation: traditional methods are obsolete (e.g. SIC)

– Created by statistics agencies for information aggregation

– Established in 1930s.

– Multiple-segment firms

Peer firms share similar financial patterns.

# Procedures

We select ratios from six broad categories (profitability, capitalization, solvency, efficiency, financial soundness, research and developments)

Next, we apply k-means clustering on the firms.

Firms that remain in the same cluster for five consecutive yers

Firms in the same clusters with i in the five years

Target firm i is selected

| t-5 | t-4 | t-3 | t-2 | t-1 | t |
| Clustering | Clustering | Clustering | Clustering | Clustering | Target year |

# Results

We use another set of variables to test whether we successfully capture the peer firms, i.e. firms that share similar financial patterns.

Clustering method significantly outperforms traditional industry methods (SIC, NAICS, GICS) in most cases.

Specifically, we

- – 1) Use regression analysis: firms' association with peer average and compare the R-squared.
- – 2) Variance analysis: within group dispersion

| Ratios | Clustering Classification | FF49 Classification | Difference | | Clustering Classification | 2-digit SIC Classification | Difference | |
|---|---|---|---|---|---|---|---|---|
| NPM | 7.06% | 0.77% | 6.29% | ** | 6.12% | 2.62% | 3.50% | ** |
| CFM | 9.91% | 0.77% | 9.14% | ** | 7.33% | 1.98% | 5.35% | ** |
| GPROF | 21.46% | 1.01% | 20.45% | * | 26.21% | 4.76% | 21.45% | ** |
| CAPITAL_RATIO | 23.70% | 0.55% | 23.16% | ** | 23.49% | 4.00% | 19.50% | ** |
| DLTT_BE | 15.40% | 0.43% | 14.97% | * | 19.13% | 2.87% | 16.27% | ** |
| DEBT_CAPITAL | 9.58% | 0.38% | 9.20% | | 16.89% | 2.67% | 14.22% | ** |
| RD_SALE | 10.62% | 1.15% | 9.47% | ** | 10.44% | 2.21% | 8.22% | ** |
| SALE_EQUITY | 10.62% | 1.15% | 9.47% | ** | 18.69% | 9.29% | 9.39% | ** |
| SALE_INVCAP | 24.82% | 0.96% | 23.86% | ** | 32.47% | 4.33% | 28.15% | ** |

Rutgers Business School

| Fiscal year | NPM | CFM | GPROF | CAPITAL_RATIO | DEBT_BE | DEBT_CAPITAL | RD_SALE | SALE_EQUITY | SALE_INVCAP |
|---|---|---|---|---|---|---|---|---|---|
| TABLE 5 | | | | | | | | | |
| Within-group dispersion comparison | | | | | | | | | |
| Ratio of SIC (2 digits) within-group dispersion to clustering within-group dispersion | | | | | | | | | |
| 1999 | 338.23 | 274.25 | 8.70 | 8.67 | 0.62 | 22.51 | 3555.49 | 0.11 | 5.42 |
| 2000 | 81.06 | 59.58 | 1.81 | 5.01 | 19.05 | 12.74 | 1.62 | 1.28 | 40.04 |
| 2001 | 0.28 | 0.36 | 0.68 | 1.09 | 4.59 | 1.70 | 0.00 | 1.81 | 0.39 |
| 2002 | 293.30 | 267.52 | 2.88 | 1.50 | 5.18 | 4.19 | 0.03 | 3.64 | 1.66 |
| 2003 | 0.76 | 0.76 | 1.79 | 2.38 | 3.67 | 5.92 | 0.46 | 5.14 | 3.95 |
| 2004 | 140.53 | 113.42 | 2.62 | 4.97 | 2.50 | 12.69 | 0.41 | 2.53 | 2.75 |
| 2005 | 15.43 | 6.67 | 6.72 | 5.25 | 0.78 | 5.99 | 1.69 | 16.68 | 58.29 |
| 2006 | 0.62 | 0.63 | 0.35 | 0.57 | 1.39 | 1.53 | 0.00 | 3.14 | 0.72 |
| 2007 | 0.68 | 0.38 | 2.30 | 2.25 | 6.66 | 1.65 | 0.02 | 6.89 | 2.38 |
| 2008 | 9.05 | 12.39 | 1.57 | 1.82 | 4.92 | 2.82 | 1.14 | 2.65 | 0.98 |
| 2009 | 1.30 | 1.26 | 0.18 | 0.95 | 3.74 | 1.01 | 2.93 | 3.11 | 0.28 |
| 2010 | 237.95 | 222.96 | 11.87 | 2.50 | 0.52 | 15.36 | 55.32 | 1.73 | 13.49 |
| 2011 | 0.00 | 0.00 | 2.64 | 1.19 | 1.06 | 1.24 | 1.14 | 5.75 | 3.38 |
| 2012 | 237.25 | 276.46 | 4.65 | 6.31 | 9.12 | 6.68 | 0.04 | 4.93 | 2.99 |
| 2013 | 791.97 | 875.54 | 8.19 | 4.76 | 34.39 | 32.02 | 51.51 | 16.43 | 23.30 |
| 2014 | 1.41 | 1.40 | 1.72 | 3.03 | 1.42 | 10.63 | 4.86 | 1.01 | 2.22 |
| $R_D>1$ year # | 12 | 11 | 13 | 12 | 12 | 14 | 8 | 13 | 12 |

Rutgers Business School

# Part 2: Virtual Consolidation-
# a closer look of multi-segment firms

Multi-segment firms have complex financials but disclose minimum information on the segment level, leaving missing pieces in the reporting. More importantly, consolidation may bury information that may be indicative of financial misconduct.

In our initial analysis, we use <u>financial ratios</u> to represent the "pattern" of individual segments and fill out the "holes".

Next, we assemble a "virtual firm"—part of its financial statement is made up of estimated values. We compare the virtual firms to actual firms.

Extension: other machine learning tools (e.g. Deep learning)

Thank you!

# Appendix

| Category | Ratio |
|---|---|
| Profitability | Net profit margin (NPM) |
| | Gross Profit/ Total assets (GPROF) |
| Capitalization | Capitalization ratio (CAPITAL_RATIO) |
| Solvency | Total debt / Capital (DEBT_CAPITAL) |
| Efficiency | Sales/equity (SALE_EQUITY) |
| | Sales/invested capital (SALE_INVCAP) |
| Financial Soundness | Cash Flow Margin (CFM) |
| | Long-term Debt/Book Equity (DLTT_BE) |
| Other | R&D expense/Sales (RD_SALE) |