Moore’s Law vs. Murphy’s Law in the Macrofinancial System
Andrew W. Lo, MIT
Macro Financial Modeling Group
June 19, 2018
The Financial Crisis

- Pension Funds
- Mutual Funds
- Sovereign Wealth Funds
- Foundation Endowments
- Hedge Funds

Rating Agencies
- Commercial Banks
- Investment Banks
- Mortgage Companies
- Fannie Mae
- Freddie Mac

Politicians

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How Could This Have Happened To Us??

Who Benefited From This Trend?:

- Commercial banks
- Credit rating agencies (S&P, Moody’s, Fitch)
- Economists
- Government sponsored enterprises
- Homeowners
- Insurance companies (multiline, monoline)
- Investment banks and other issuers of MBSs, CDOs, and CDSs
- Investors (hedge funds, pension funds, mutual funds, others)
- Mortgage lenders, brokers, servicers, trustees
- Politicians
- Regulators (CFTC, Fed, FDIC, FHFA, OCC, OTS, SEC, etc.)

“A Rising Tide Lifts All Boats”
Technology

Moore’s Law

curve shows transistor count doubling every two years

Date of introduction

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Technology and the Financial System

Buttonwood Agreement
May 17, 1792
Technology and the Financial System

Average Daily Volume of Exchange-Listed Options and Futures

\[ y = 0.14x + 16.601 \]
\[ R^2 = 0.8777 \]
Technology and the Financial System

World Population, 10,000 BC to 2017

Technology can have unintended consequences
Mea Culpa

Macroeconomic Models for Monetary Policy: A Critical Review from a Finance Perspective*

Winston W. Dou, Andrew W. Lo, Ameya Muley, Harald Uhlig†

This Draft: 14 January 2017

We provide a critical review of macroeconomic models used for monetary policy at central banks from a finance perspective. We review the history of monetary policy modeling, survey the core monetary models used by major central banks, and construct an illustrative model for those readers who are unfamiliar with the literature. Within this framework, we highlight several important limitations of current models and methods, including the fact that local-linearization approximations omit important nonlinear dynamics, yielding biased impulse-response analysis and parameter estimates. We also propose new features for the next generation of macrofinancial policy models, including: a substantial role for a financial sector, the government balance sheet and unconventional monetary policies; heterogeneity, reallocation, and redistribution effects; the macroeconomic impact of large nonlinear risk-premium dynamics; time-varying uncertainty; financial sector and systemic risks; imperfect product market and markups; and further advances in solution, estimation, and evaluation methods for dynamic quantitative structural models.

Keywords: Macrofinancial Models; Dynamic Stochastic General Equilibrium Models; Macropolicy; Macroeconomic Policy; Systemic Risk; Monetary Policy Analysis

JEL Classification: G12, G29, C51

– N. Kocherlakota (2009)
Many Narratives Have Emerged

- Population Growth
- Technology
- Fear
- Greed
- Globalization
- Prolonged Bull Market

Regulators, Politicians, Homeowners, Economists
CDOs, CDSs, Rating Agencies, Insurers
Commercial vs. Investment Banks
Subprime Mortgages

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Many Narratives Have Emerged


- N rays
- Polywater
- Urbanization
- etc.

Reading About the Financial Crisis: A Twenty-One-Book Review

ANDREW W. LO

The recent financial crisis has generated many distinct perspectives from various quarters. In this article, I review a diverse set of twenty-one books on the crisis, chosen written by academics, and ten written by journalists and one former Treasury Secretary. No single narrative emerges from this broad and often contradictory collection of interpretations, but the sheer variety of conclusions is informative, and underscores the desperate need for the economics profession to establish a single set of facts from which more accurate inferences and narratives can be constructed.

19 June 2018

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Many Narratives Have Emerged

**Academics**
- Acharya, Richardson, van Nieuwerburgh, and White, 2011, *Guaranteed to Fail*
- Akerlof and Shiller, 2009, *Animal Spirits*
- French et al., 2010, *The Squam Lake Report*
- Garnaut and Llewellyn-Smith, 2009, *The Great Crash of 2008*
- Gorton, 2010, *Slapped by the Invisible Hand*
- Johnson and Kwak, 2010, *13 Bankers*
- Rajan, 2010, *Fault Lines*
- Reinhart and Rogoff, 2009, *This Time Is Different*
- Roubini and Mihm, 2010, *Crisis Economics*
- Stiglitz, 2010, *Freefall*

**Journalists**
- Cohn, 2009, *House of Cards*
- Farrell, 2010, *Crash of the Titans*
- Lewis, 2010, *The Big Short*
- Lowenstein, 2010, *The End of Wall Street*
- McLean and Nocera, 2010, *All the Devils Are Here*
- Morgenson and Rosner, 2011, *Reckless Endangerment*
- Paulson, 2010, *On the Brink*
- Sorkin, 2009, *Too Big to Fail*
- Tett, 2009, *Fool's Gold*
- Zuckerman, 2009, *The Greatest Trade Ever*
Many Narratives Have Emerged

Popular Narratives of the Crisis

- Crisis started with a “run on repo”
- Bankers didn’t have enough “skin in the game”
- Predatory lending created the subprime crisis
- No one saw the crisis coming
- Devotion to market efficiency caused the crisis
- Wall street bonuses were too high
- Changes in regulation allowed huge increases in leverage
Unanswered Questions

1. To what extent did regulatory forbearance contribute to the crisis?
2. Would better/different bank accounting practices have changed the extent of the crisis?
3. Would better monetary models have allowed central banks to avoid the crisis?
4. What role did culture play?
5. Can we develop reliable early warning signals for financial crises?
What Can Be Done?

1. Recognize that we have a new problem: systemic risk
2. Propose systemic risk measures (Bisias et al. 2012)
3. Adopt a systems and adaptive approach to regulation
4. Develop new technologies that address human nature
5. Train more people in macrofinance (especially Ph.D.s)

Academia Has A Critical Role To Play
- The scientific method ("establishing the phenomenon")
- Tenure is a privilege but also a responsibility
- Focus on problems and measurement rather than disciplines
What Do We Know About the Economy?

- Non-farm payroll: 223K in May 2018
- Unemployment: 3.8% in May 2018
- Inflation: 2.8% in May 2018
- GDP growth: 2.2% in 2018Q1
- Housing starts: 1,287K in Apr 2018
- Consumer credit: $3.9T (+2.9%) in Apr 2018
- etc.
What Do We Know About Hedge Funds?

- You can’t manage what you don’t measure
What Do We Know About Hedge Funds?

As of June 30, 2017

<table>
<thead>
<tr>
<th>Rank</th>
<th>Manager</th>
<th>Assets</th>
<th>Change from 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bridgewater Associates</td>
<td>$123,000</td>
<td>19.5%</td>
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<tr>
<td>2</td>
<td>AQR Capital Mgmt.</td>
<td>$76,619</td>
<td>21.6%</td>
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<td>Man Group</td>
<td>$53,100</td>
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<tr>
<td>4</td>
<td>Renaissance Technologies</td>
<td>$48,600</td>
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<tr>
<td>5</td>
<td>Two Sigma</td>
<td>$35,400</td>
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<tr>
<td>6</td>
<td>Millennium Mgmt.</td>
<td>$34,373</td>
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<td>7</td>
<td>Elliott Mgmt.</td>
<td>$32,700</td>
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<td>8</td>
<td>Baupost Group</td>
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<tr>
<td>9</td>
<td>BlackRock (BLK)</td>
<td>$27,615</td>
<td>-3.4%</td>
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<tr>
<td>10</td>
<td>Winton Capital Mgmt.</td>
<td>$27,559</td>
<td>-16.6%</td>
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<tr>
<td>11</td>
<td>D.E. Shaw Group</td>
<td>$27,486</td>
<td>1.7%</td>
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</table>

LTCM?? $4 $6.2
Shadow Banking Sector
Predicting Social Security numbers from public data

Alessandro Acquisti and Ralph Gross
Carnegie Mellon University, Pittsburgh, PA 15213

Information about an individual’s place and date of birth can be exploited to predict his or her Social Security number (SSN). Using only publicly available information, we observed a correlation between individuals’ SSNs and their birth data and found that for younger cohorts the correlation allows statistical inference of private SSNs. The inferences are made possible by the public availability of the Social Security Administration’s Death Master File and the widespread accessibility of personal information from multiple sources, such as data brokers or profiles on social networking sites. Our results highlight the unexpected privacy consequences of the complex interactions among multiple data sources in modern information economies and quantify privacy risks associated with information revelation in public forums.

identity theft | online social networks | privacy | statistical reidentification

number (SN). The SSA openly provides information about the process through which ANs, GNs, and SNs are issued (1). ANs are currently assigned based on the zipcode of the mailing address provided in the SSN application form [RM00201.030] (1). Low-population states and certain U.S. possessions are allocated 1 AN each, whereas other states are allocated sets of ANs (for instance, an individual applying from a zipcode within New York state may be assigned any of 85 possible first 3 SSN digits). Within each SSA area, GNs are assigned in a precise but nonconsecutive order between 01 and 99 [RM00201.030] (1). Both the sets of ANs assigned to different states and the sequence of GNs are publicly available (see www.socialsecurity.gov/employer/stateweb.htm and www.ssa.gov/history/ssn/geocard.html). Finally, within each GN, SNs are assigned “consecutively from 0001 through 9999” (13) (see also [RM00201.030], ref. 1.)
Is There A Compromise Between Data Privacy and Transparency?
Secure Multi-Party Computation

\[ Y_1 = S_1 + X_1 \]

Andrew

\[ Y_2 = Y_1 + S_2 + X_2 \]

Lars

\[ Y_n = Y_{n-1} + S_n + X_n \]

Amy

\[ Y_n = Y_n \]

\[ Z_1 = Y_n - X_1 \]

Andrew

\[ Z_2 = Z_1 - X_2 \]

Lars

\[ Z_{n-1} = Z_{n-1} - X_n \]

Amy

\[ \frac{1}{n} \sum_{i=1}^{n} S_i = \frac{1}{n} Z_n \]
Privacy and Transparency

Transparency and Privacy Can **Both** Be Achieved

- Individual data is kept private, e.g., RSA
- Encryption algorithms are “collusion-robust”
- Aggregate risk statistics can be computed using encrypted data
  - Means, variances, correlations, percentiles, Herfindahl indexes, VaR, CoVaR, MES, etc.
- Privacy is preserved, no need for raw data!
Privacy and Transparency

Real Estate Loans Outstanding

![Graph showing the trend of real estate loans outstanding from 1986 to 2010. The graph compares the aggregate value with individual bank values for Bank of America, JPMorgan, and Wells Fargo. The values increase significantly around 2007-2008, indicating the peak of the housing boom.](image-url)
Privacy and Transparency

Real Estate Loans Outstanding

![Graph showing real estate loans outstanding from Jun-86 to Jun-10 with lines for Aggregate, Bank of America, JPMorgan, and Wells Fargo.](image-url)
Conclusion

- Technology has transformed everything!
- Financial markets are vastly better off
- But new challenges have emerged
- We can do better
- We have to do better
- Regulation has to account for technology and how it interacts with human behavior
- We must cut across disciplines to create a more robust Financial System 2.0
Thank You!
Additional References

Additional References


Additional References