The Social Welfare Costs of Fraud:
Evidence from an agent-based model

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Research Question

How does financial statement fraud affect social welfare?

- Specifically, how does it affect:
  - Economic learning
  - Consumer welfare

Motivation

Frustrated policy analysis

- For any evaluation of regulation, we want to know aggregate costs and benefits
- Surprisingly little known about real economy costs associated with financial statement fraud
  - What does US$460 billion market cap loss from Enron, WorldCom, Tyco, Qwest, Global Crossing mean?
- And this is even before we try to measure the amount of fraud reduction attributable to any policy action!

One common anecdote tossed around

- AT&T claimed it had destroyed its business model in an attempt to mimic WorldCom's illusory low costs and large customer base.
- WorldCom's fraudulent broadband traffic got incorporated into government planning and regulation documents.
Literature

Lots of people look at effect of fraud on shareholders

- Thought there remain many unanswered questions (what does fraud say about efficient capital market hypothesis?)

Most of those who look at aggregate social costs look only at shareholders

- Easterbrook and Fischel, 1985; Arlen and Carney, 1992; Alexander 1996; Langevoort, 1996; Lev, 2003; Booth, 2005
- Due to market-clearing constraint, aggregate shareholder loss is zero
- Acknowledge there may be collateral costs but assume they are small

Very recently, a few people have taken these collateral costs seriously

- Sadka 2004, 2006; Kedia and Philippon, 2007; Durnev and Mangen, 2007; Bagnoli and Watts, 2008
- Find evidence consistent with fraud affecting competitors' price/quantity decisions, fraudsters' investment and hiring decisions

Our work also connects with evolutionary approach to economic growth

- Schumpeterian tradition (e.g. *creative destruction*)
- Nelson and Winter, 1974 and Nelson 1995 are good places to start
- Firms search for new technologies, products, marketing techniques in an attempt to survive "the market"
  - Fitness is measured (usually) by a measure of profit
- We ignore most of the subtle issues raised by the evolutionary approach
  - Focus instead on the consequences of assigning the "wrong" fitness to a firm

Hypothesis

Fraud disrupts productive economic learning:

- Firms imitate the wrong competitor
- Better technologies/products/etc. are abandoned in favor of worse approaches

We expect to see
• Slower convergence on consumer preferences
• Lower consumer welfare
• More volatility
• Some correlation between fraction of fraudsters in population and consumer welfare (e.g. the more fraud there is, the worse off consumers are)

**Model Overview**

*A model of producers and consumers where each wants to maximize a utility function based on distance between what is offered and what is demanded where firms can improve by updating their production strategy, and consumers can 'shop' around a local neighbourhood.*

<table>
<thead>
<tr>
<th>Agents</th>
<th>Consumers</th>
<th>Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristics</td>
<td>Have attribute preference $a$</td>
<td>Have attribute decision $b$</td>
</tr>
<tr>
<td>Incentives</td>
<td>Minimize $</td>
<td>a-b</td>
</tr>
<tr>
<td>World</td>
<td>Inhabit 3x3 locality, includes self</td>
<td></td>
</tr>
<tr>
<td>Information</td>
<td>Attributes of neighbours</td>
<td>Reported revenues of neighbours</td>
</tr>
</tbody>
</table>

*Implementation: NetLogo*

**Details: Fraud & Learning**

**Fraud implementation**

1. *Firm reporting:* Firms know actual revenue of self only -- report publicly (to neighbourhood) reported revenue

   ♦ If Fraudster

      1. Under *stochastic fraud:* commit 'fraud' with probability $p$
      2. Under *endogenous fraud:* commit 'fraud' only if actual-revenue $\leq$ below a set limit (revenue-threshold)

   ♦ 'Commit fraud' --> Report max-revenue (as reported-revenue)

2. *Committing fraud* -- Variables:
1. Fraction of population who are prone to fraud (*Fraudster Fraction*)
2. Propensity of fraudsters to commit fraud (*Fraud Probability*)

◊ NB: Under *endogenous fraud* two triggers required:
◊ Fraudster randomly chosen to have capacity for fraud
◊ Fraudster $\text{actual-revenue} \leq \text{revenue-threshold}$

**Firm Learning**

1. Consider $\text{reported-revenue}$ of neighbours
2. Copy (with mistake-making) attribute decision of *best neighbour* (split ties equiprobably), (includes self)

♦ NB: Bayesian learning -- 50% self, 50% best performer
♦ NB: firms only update if other firm $\text{reported-revenue}$ is *strictly better* than self $\text{actual-revenue}$ (come back to this...)

**Details: The World**

<table>
<thead>
<tr>
<th>Initial Conditions</th>
<th>Heterogeneous Firms</th>
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<tbody>
<tr>
<td>Homogeneous Consumers</td>
<td><img src="image" alt="Homogeneous Consumers" /></td>
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<table>
<thead>
<tr>
<th>Long-run Conditions</th>
<th>Fraudster World</th>
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<tbody>
<tr>
<td>Honesty World</td>
<td><img src="image" alt="Honesty World" /></td>
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</tbody>
</table>
NetLogo screenshot
Results: Social Welfare Cost of Fraud

What is the impact of fraudsters on social welfare?

- Welfare Cost measure: Measure average distance |a-b| over all relationships

It turns out, there are clear effects

- Exact nature depends on combination of variables
- Effects several dimensions
  - Convergence speed (or even convergence existence)
  - Long-run welfare levels
- Effect severity depends on location relative to (potential) fraudster

Social Welfare: Convergence

Base-line (stochastic fraudsters)
Endogenous fraudsters
Social Welfare: Long-run Means

Mean:

• Take first 90 periods as transient
Findings

1. The first cut is the deepest
   - Even a few fraudsters can cause huge social cost
2. If you can't beat them, join (encourage) them
   - Surprising non-linear effect of the first few fraudsters
   - Apparently worse than with many fraudsters (seen in other implementations)
3. Desperation doesn't pay
   - Endogenous fraudsters more damaging than static fraudsters
   - Why?
     - .. Fraud now committed by only the worse performers
     - Attributes will be naively copied by competitors who see 'max-revenues'
The CEO Cover-up

Recall assumption that firms only update if reported-revenue of a neighbour is strictly better than actual-revenue of self.

- What if, they update based on reported-revenue of self?
- That is, CEO pushes ahead with reform based on rivals despite private information to the contrary
- Or, CEO tries to align current decisions with fraudulent reporting so as to look (at least) consistent
  - Why? CEO can’t say one thing in company report then act as if company is distressed!
  - Actually, consistent with findings Kedia and Philippon, 2007

Information problem even worse

- Non-linearity more pronounced than when actual-revenue (private information) taken into account.
**Information & Fraud**

.. Essentially an *information* based argument about fraud

- Signalling of *the good firm* corrupted by reporting fraud
- However, information comes in two forms:
  1. 'Meaningful' information (patterns, rules etc.)
  2. 'Junk' information (noise)

*A little bad information is the worst*

- Small amount of 'bad' information has worse marginal effect
- More 'bad' information has less of an effect
- Lots of bad information (noise) equivalent to randomising attribute decisions
  ♦ *Better* than being led astray by some fraudulent firms

**Fraudsters in the Neighbourhood?**

How is Revenue for a firm affected by the number of fraudulent firms in its neighbourhood?

Distinguish between:

1. *Genetic Fraudsters* -- where N neighbours *actually* (by nature) of a fraudulent type
2. *Instantaneous Fraudsters* -- where N neighbours have committed fraud *in this period* (irrespective of their 'nature')

<table>
<thead>
<tr>
<th>Stochastic Fraud</th>
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<td>Genetic</td>
<td>Instantaneous</td>
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Endogenous Fraud

Genetic

Instantaneous
Future directions

Model Development

- Heterogeneous consumers and/or changing consumer taste
- "Smarter" approach to skepticism
- Can we evolve a propensity to commit fraud?
- Does model findings transfer to hiding costs rather than exaggerating revenues?
- Introduce enforcement, bankruptcy
- More separation between CEO/firm actions?

Applications

- Can simulations help us find empirical tests?
  - How do we prove these costs?
Does work suggest policy levers that might be available?
  - Implications for accounting rule development?
  - Cost-benefit of fraud prevention measures?
• Are there industry/issue specific applications?
  - Interesting possible application to environmental remediation market