

Leviathan
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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.

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

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*)

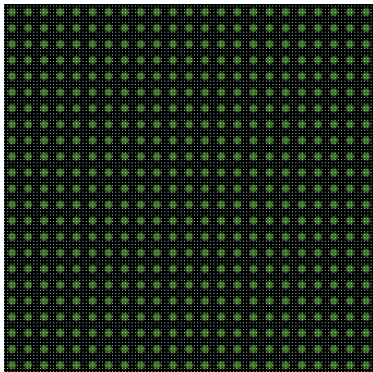
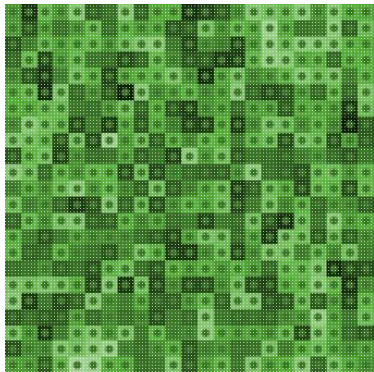
- ◇ NB: Under *endogenous fraud* **two** triggers required:
- ◇ Fraudster randomly chosen to have capacity for fraud
- ◇ Fraudster *actual-revenue* \leq *revenue-threshold*

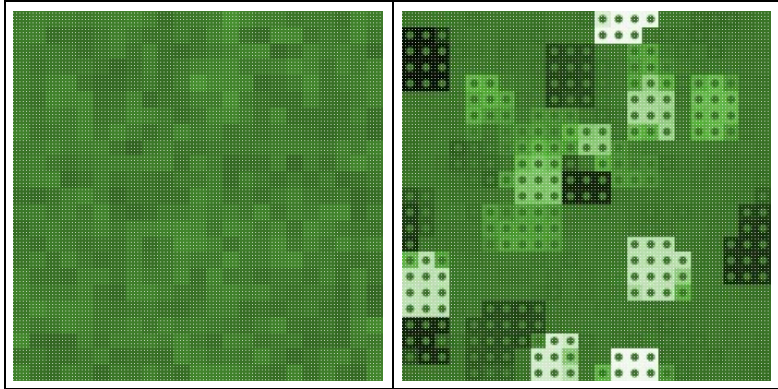
Firm Learning

1. Consider *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 *reported-revenue* is *strictly better* than self *actual-revenue* (come back to this...)

Details: The World

Initial Conditions	
<i>Homogeneous Consumers</i>	<i>Heterogeneous Firms</i>
	
Long-run Conditions	
<i>Honesty World</i>	<i>Fraudster World</i>



NetLogo screenshot

NetLogo — faud-ii-v080110-1 {/Users/sangus/Desktop/simon-work/pheno-fraud}

Interface Information Procedures

Edit Delete Add Button normal speed update view continuously Settings...

On Off experiment-mode?

'Genetic' Fraudsters...

fraudster-fraction 0.50

fraudster-fraud-prob 0.50

With additional R trigger...

On Off endogenous?

fraud-threshold 0.00

Learning details

adjustment-factor 0.50

mutation-value 0.01

World setup

firm-density 1.00

neighb-type Moore

consumer-heterogen 0.00

ticks: 38 3D

show-consumer-toggle

setup go

max-lr-abs-tol 5.0E-5

sensitivity 50

convergence 0

Log Mean Consumer Tension Pens

Mean LR Tension 0

Max LR Tension (abs) 0

Percent fraud Pens

percent-fraud 0.163

R by Neighb Fraud-intensity (genetic) Pens

R by Neighb Fraud-intensity (inst.) Pens

Command Center

Clear

observer>

Results: Social Welfare Cost of Fraud

What is the impact of fraudsters on social welfare?

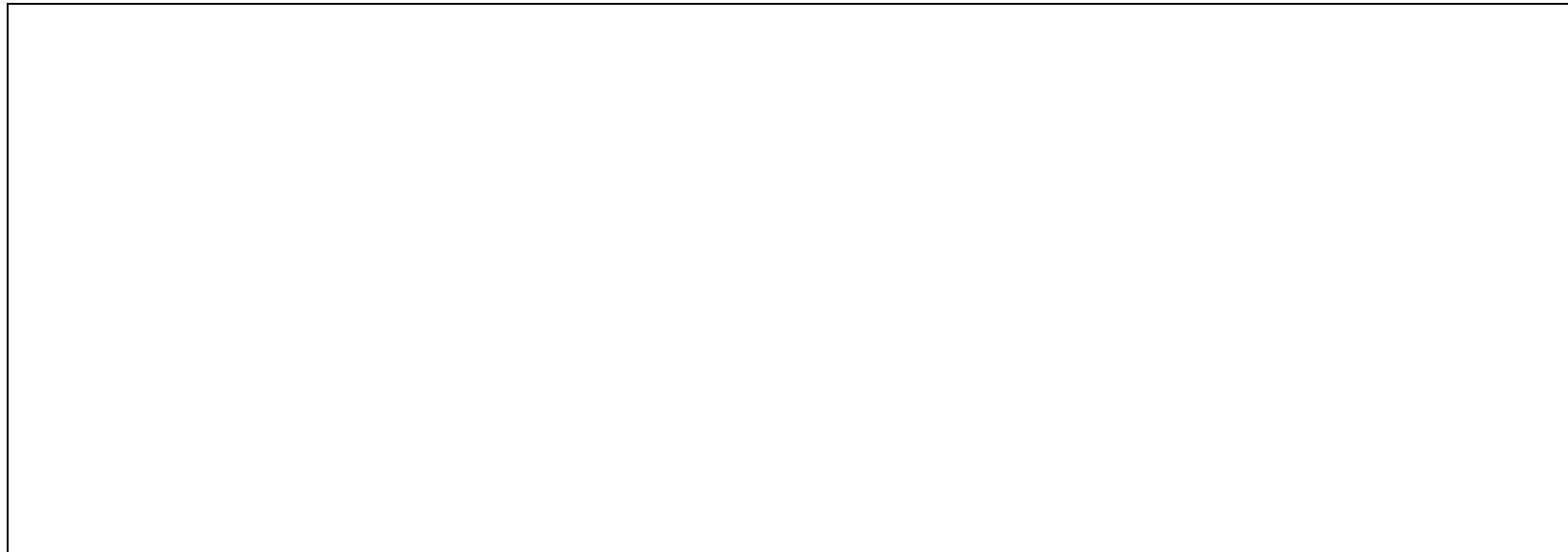
- Welfare Cost measure: Measure average distance $|a-b|$ over all relationships

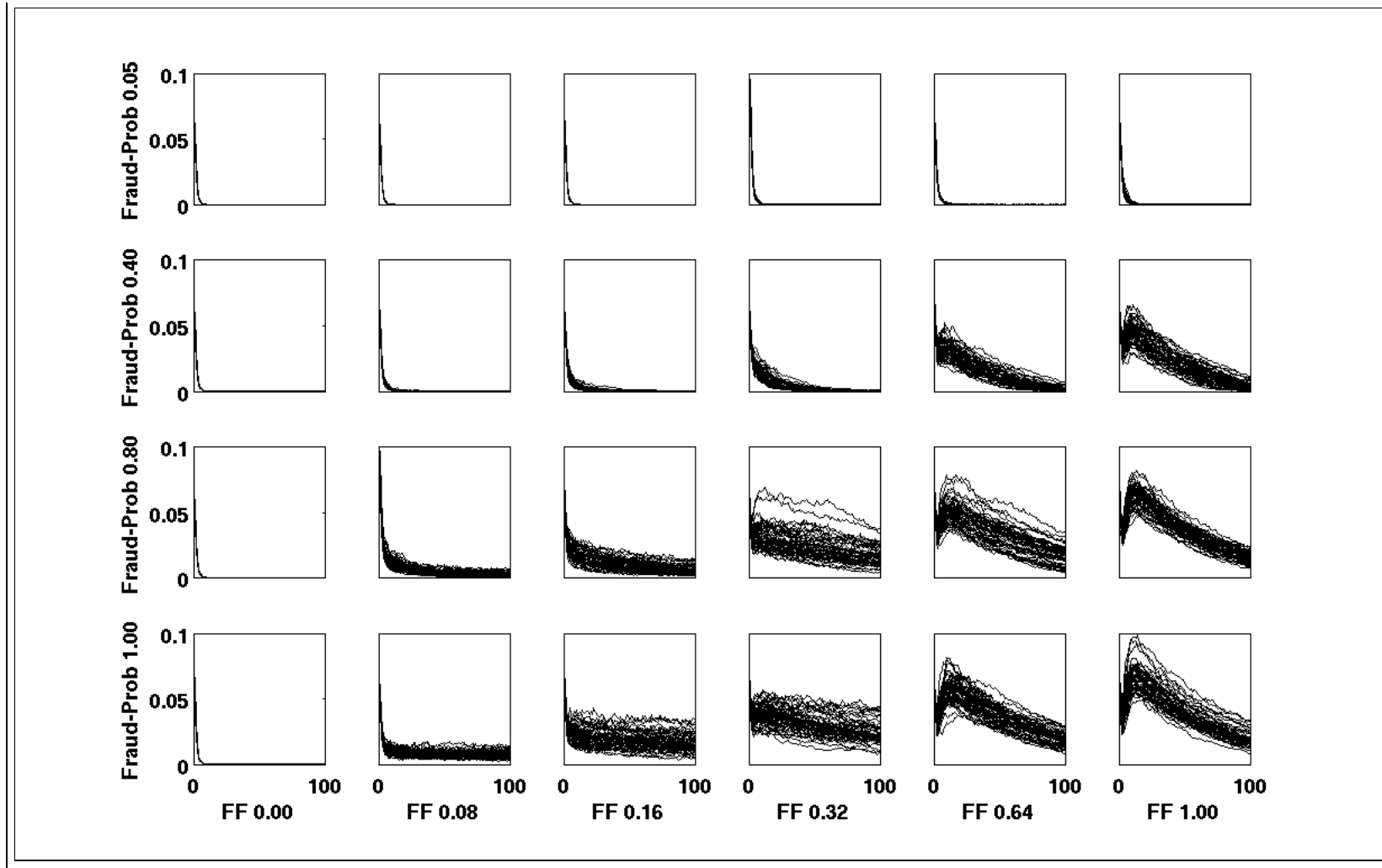
It turns out, there are clear effects

- 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

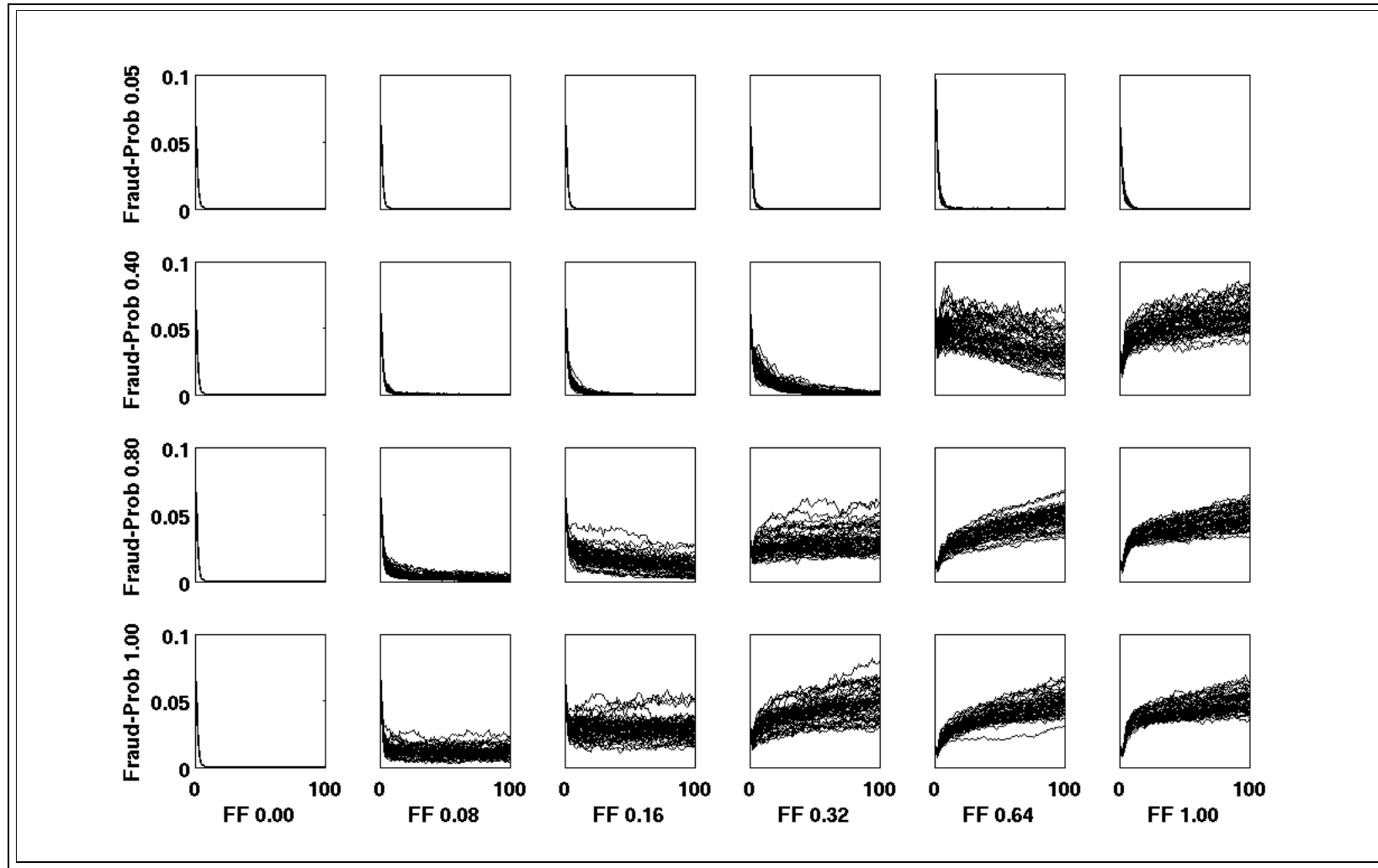
Social Welfare: Convergence

Base-line (stochastic fraudsters)





Endogenous fraudsters

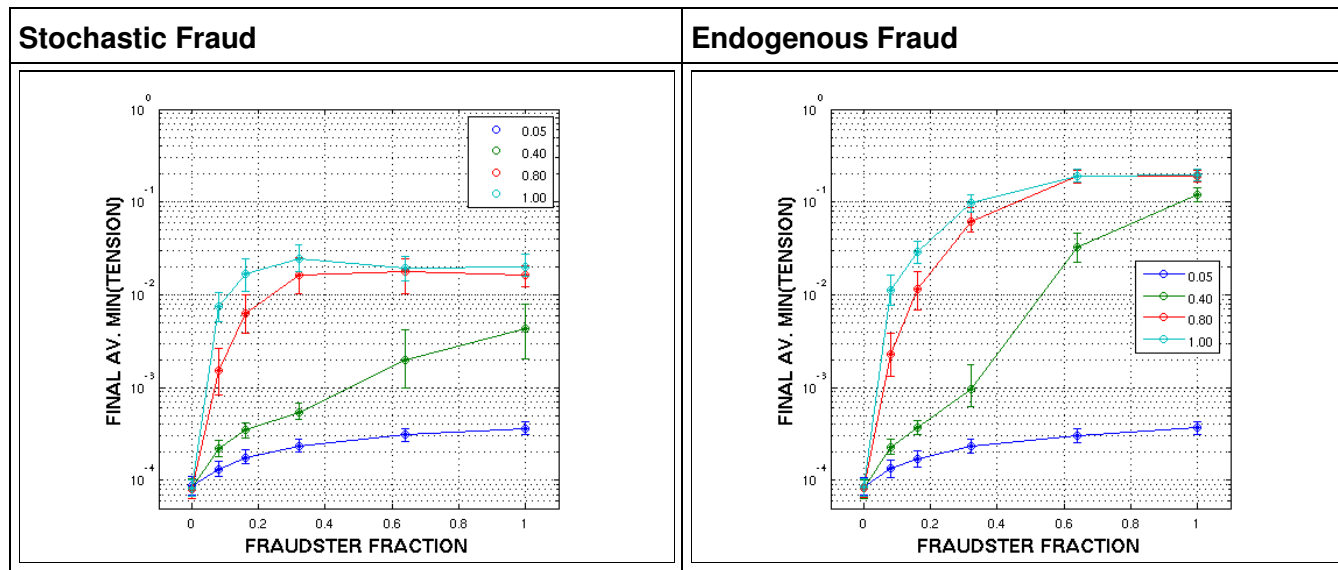


Social Welfare: Long-run Means

Mean:

- Take first 90 periods as transient

- Mean of Welfare Measure in last 10 periods



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*

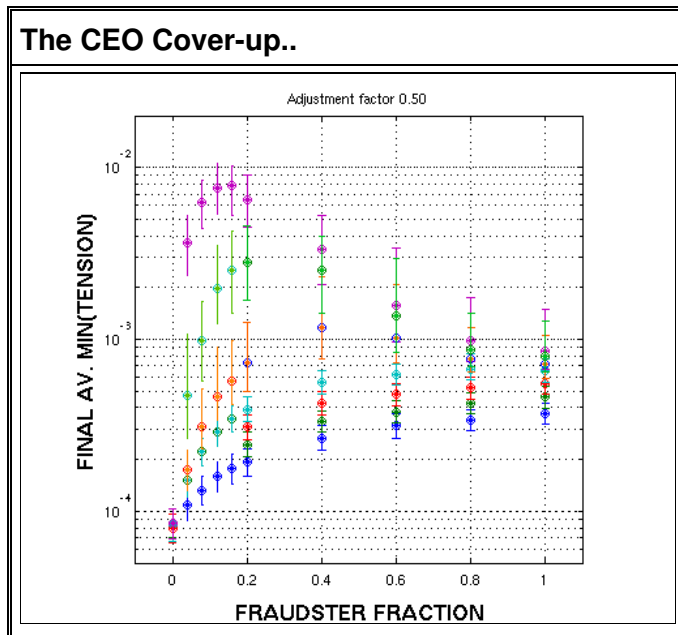
- ◆ Surprising non-linear effect of the first few fraudsters
- ◆ Apparently *worse* than with many fraudsters (seen in other implementations)

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

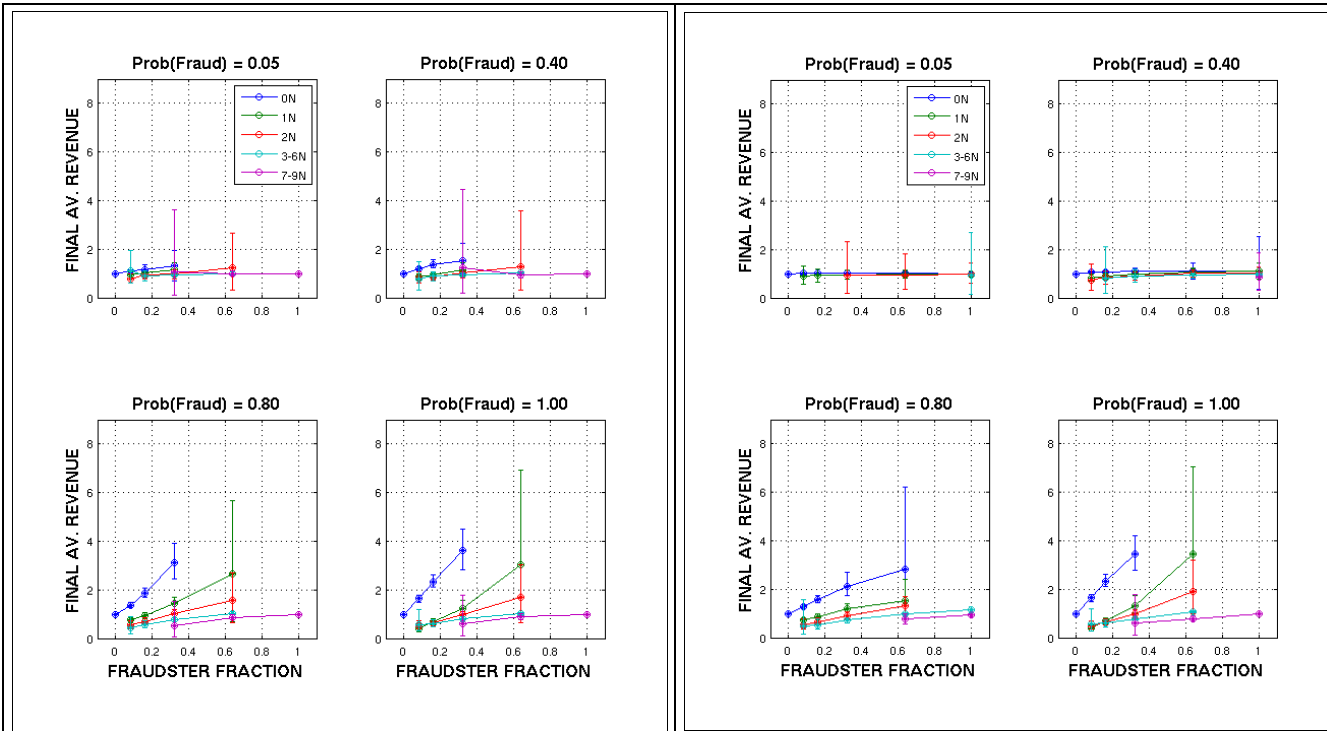
Fraudsters in the Neighbourhood?

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')

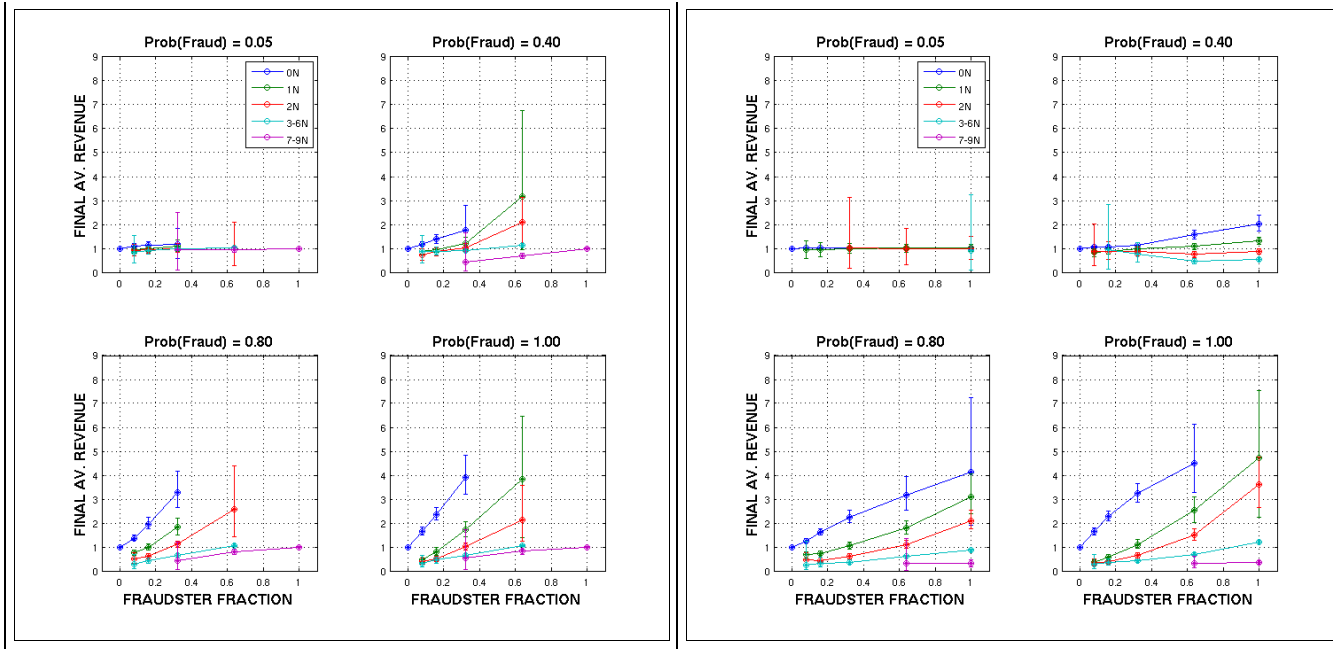
Stochastic Fraud	
Genetic	Instantaneous



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