Dynamics of a Voluntary Livestock Disease Control Program

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Information and Value of Biolkogical Goods

- Biological goods are interesting in that engineering is often inadequate for the desired level of control
- Food items are of particular concern as implications of failure in control can be very large
- Food production is often a fragmented sector, and information/agency problems may arise at production chain seems
  - Melamine in food/feed (the better example)
  - Animal disease that may be zoonotic (we’ve done empirics here, but doesn’t fit model as well)

Willingness to Pay for Product

- Suppose there are two product types; high, or H, and low, or L
  - Consumers might like to know that they are getting H, and would pay more
  - But producers may be ignorant too, have to incur cost to test for type and may not want to report outcome
  - So there may be two goods in the market; a) tested and known to be H, and b) the rest, i.e., a pool of *i*) untested and *ii*) tested and found by producer to be L
  - Incentive to test will be given by gap between price for known good H product and price for the rest

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- So the question is how to go about getting the purchaser information that will cause them to pay more for the product?

Application

- Johne's Disease (paratuberculosis) is a bovine disease that U.S. government seeks to control through a voluntary reporting scheme
- Infectious and eventually causes decreased productivity in beef and dairy cattle. Some concern about zoonotic implications
- Scheme involves voluntary testing by herd owner and test-based herd classification. Owner selling, e.g., dairy replacement heifers can use this information to boost price or remain silent
- Silent herds: either *i*) don't test or *ii*) do & don't tell

Model

- We extend Shavell, RAND J. Econ. (1994) to study dynamics
- Dynamic model generalization of Viscusi's 1978 Bell J. Econ. example of how certification can reverse Akerlof's Lemons problem
- Provide the dynamics of arriving at a Nash equilibrium on testing and disclosure (but not necessarily the best equilibrium)

Caveats

- Model to follow does not deal with disease transmission. And the version to be presented doesn't address on-farm benefits from disease control
- Intent is to look closely at the how the voluntary scheme might play out over time to see if it fosters a more transparent production environment

Model Outline

V : value of disease-free animal

αV: value of diseased animal

r_t : time t true disease-free rate in a herd

$[r_t + (1 - r_t)\alpha]V$: mean value of animal from herd

$F(r)$: distribution of disease-free rates over herds

r_t^S : time t average disease-free rate in silent herds

c : participation cost, distribution $G(c):[\underline{c}, \overline{c}] \to [0,1]$

c and r_t are statistically independent

Incentives

Price outside program: $[r_t^S + (1 - r_t^S)\alpha]V$

Price in program: $\begin{cases} [r_t^S + (1 - r_t^S)\alpha]V, & \text{if } r_t \le r_t^S \\ [r_t + (1 - r_t)\alpha]V, & \text{if } r_t > r_t^S \end{cases}$

Expected premium:

$$I_t(r_t^S) = (1 - \alpha)V \int_{r_t^S}^{1} (r_t - r_t^S)\, dF(r_t)$$

Fraction that clear participation costs:

$$\eta_t \equiv G\left(I_{t-1}(r_{t-1}^S)\right)$$

Bayesian Dynamics

Share of silent producers that participate:

$$\pi\left[G\left(I_t(r_t^S)\right)\right] \equiv \frac{G\left(I_t(r_t^S)\right)F(r_t^S)}{\underbrace{G\left(I_t(r_t^S)\right)F(r_t^S)}_{\text{saw result \& stayed quiet}} + \underbrace{1-G\left(I_t(r_t^S)\right)}_{\text{didn't test}}}$$

Expected disease-free rate for silent producers:

$$r_t^S = \underbrace{\pi\left[G\left(I_t(r_t^S)\right)\right]}_{\text{joined but silent}} \times \underbrace{E[r_t \mid r_t \leq r_t^S]}_{\text{why silent}} + \underbrace{\left(1-\pi\left[G\left(I_t(r_t^S)\right)\right]\right)}_{\text{didn't join}} E[r_t]$$

Period t : Producers see premium I_{t-1}

& make a participation decision

↓

Proportion η_t of producers join the program

↓

Test results revealed, participants decide on disclosure given silent producer disease-free rate, r_{t-1}^S, and premium it supports

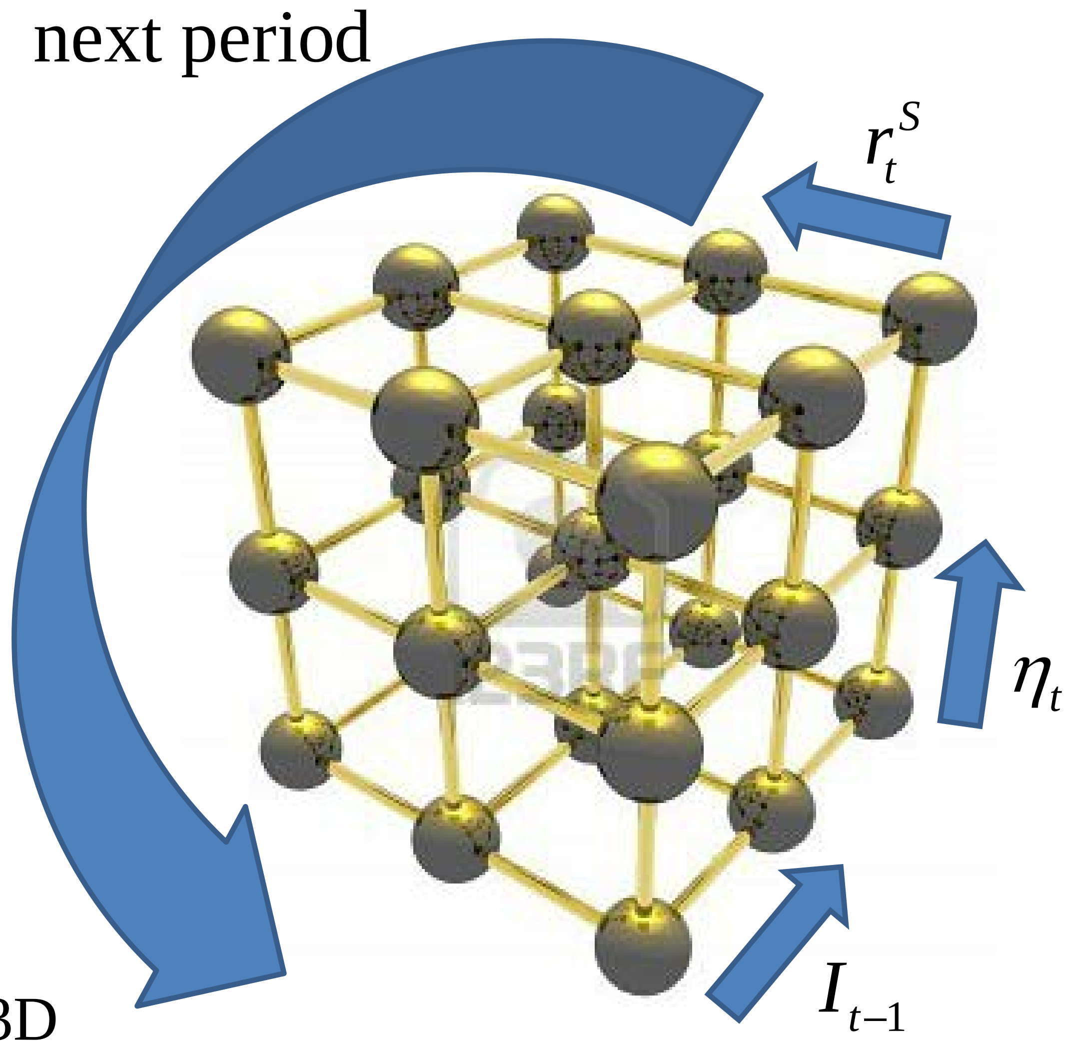
↓

r_t^S and so I_t are determined

↓

Move on to period $t+1$

Momentum on a Lattice



Think of a point lattice

that extends indefinitely in 3D

Momentum Result

Over time

i) participation rate rises;

ii) mean disease-free rate of silent producers falls;

iii) premium from program participation rises;

Or $$I_0 \le I_1 \le I_2 \le \quad \ldots \quad \le I_\infty$$

$$\eta_0 \equiv 0 \le \eta_1 \le \eta_2 \le \quad \ldots \quad \le \eta_\infty$$

$$r_0^S \equiv E[r] \ge r_1^S \ge r_2^S \ge \quad \ldots \quad \ge r_\infty^S$$

Draining the Swamp?

All producers are silent to begin with.

Growers see premium I_0

and make program choice η_1.

As growers enter program, mean

disease-free rate for silents r_1^S falls.

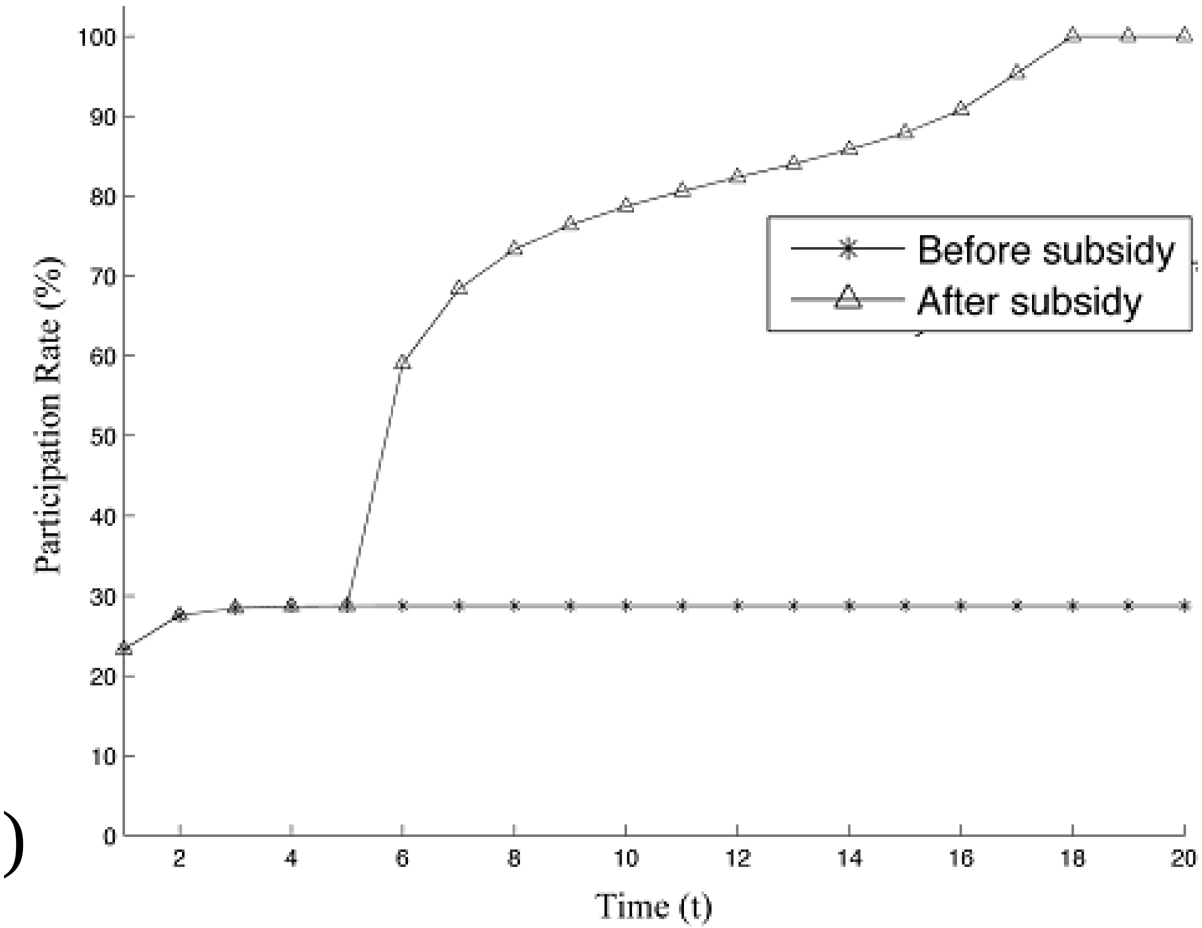
This raises I_1 so more enter program

(or η_2 rises) and so r_2^S falls.

And so on to possible convergence

One Application: Tipping

- Momentum can stall. In our Johne's disease simulations a subsidy to some high cost growers could tip equilibrium, as in theory of Heal & Kunreuther (2006)



Policy

- Educating public and providing companies with opportunities to credibly communicate a quality trait might allow the market to get rid of bad actors

Sanyuan milk tested negative for melamine and is safe

Policy

- But
  - Nash equilibrium arrived at may not be the best even if people believe disclosure. *In strategic complementarities games, highest equilibrium (in this case highest disclosure) is generally the best NE*
  - People may not believe disclosure claims
- A view of government's roles are to ensure trust in disclosure claims and then push toward higher equilibrium

Questions