Alternatives to Managing Antibiotics Demand in Dairying

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U.S, farm antibiotics regulation background

Medically important antibiotics

P&P = Pigs&Poultry, B= Beef,
NLD = Non-lactating dairy
DCT = Dry cow therapy

	To treat	To control	To prevent	Pure production
In feed, water	P&P, B, NLD	P&P, B, NLD	P&P, B, NLD	~~P&P, B, NLD~~
Syringe, one dose	Above +lactating dairy	Above + DCT	Above + DCT	Not used

US FDA Veterinary Feed Directive or prescription since 2017

Prescription since 2017

What antibiotics do? Control, capital, labor I

Source: Still from Modern Times (1936)

Historically

capital

*large scale,
*rigid in location, action

labor

*scalable
*adaptable in location, action

Confinement, genetically cookie cutter animals, + health inputs allowed for capitalization of animal and increasingly agriculture

Removed weather and biology (dna variability, pests)

Ensured uniformity

What antibiotics do? Control, capital, labor II

- Traditionally capital efficiency was constrained by non-uniformities that limit agricultural throughput

Antibiotics & other control inputs

Uniform raw materials

Automate, high capital, low labor, high fixed costs & scale. Uniformity and quality improve further

New sensor, etc., technologies *may* change things as they adapt to non-uniformities

- To be clear, antibiotics etc. are useful in their own right and not just in how they impact control

Paradox?

- Antibiotics are type of input that allowed for capital infusions into agriculture and labor substitution
- Yet when asked about managing antibiotics removal, farmers don't look to more labor input. They mention further capital investments. Investments can
  - Make cleaning easier
  - Ship product quicker (e.g., milk & SCC)
  - Learn about problems sooner
- Evidence: gains from antibiotics now much less than before (Key & McBride 2014)

Source http://www.salvagetimes.co.uk/vintage-items-for-sale/

Investment issues, and roles to fix demand, I

Data from dairy herd improvement testing, 2017			
Herd size (cows)	Avg. yield, lb./day	Avg. Somatic Cell Count	Herd test days, SCC > 400K cells/ml
50-99	70.7	217	9.7
150-199	75.3	202	5.6
300-499	80.7	194	4.0
1,000-1,999	82.3	194	2.0
>3,000	77.1	187	0.6

US Council on Dairy Cattle Breeding, Research Report SCC19 (Feb. 2018).

Investment issues, and roles to fix demand, II

US Hogs & Pigs Report, Sept.-Nov. 2017	
Herd size (sows)	Pigs per litter
100-499	8.6
500-999	9.2
1,000-1,999	9.6
2,000-4,999	10.5
≥ 5,000	10.8

- These are sanitation issues
- For whatever reason, larger enterprises tend to manage them better than smaller ones
- Restricting access to antibiotics may put further pressure to scale up
- Implications for policy

Specifics, dairying

Source: https://www.youtube.com/watch?v=YwVaE4DBOmQ

- Antibiotics have been widely applied in dairying, for disease
  - prevention
  - treatment
- Animals sufficiently valuable to treat individually
- Used mainly for udder inflamation (mastitis) but also for respiratory issues, lameness
- Few other choices for infected animal

Dairy cows are somewhat different

- Antibiotic residues not allowed in milk
- Milk is a flow and not a harvest product
- Dairy cows are more long-lived
- Mastitis is distinctive problem: permanent tissue damage
- Will be hard to remove antibiotics from dairy, few other choices

What of organics?

- Mastitis a contagious disease, being passed during milking and from environmental contamination
- Emphasis on prevention (biosecurity, caring labor, sanitary capital)
- Once animal has an issue, can try treat without antibiotics. But, as is often the case, if problem persists then cow is either
  - i) culled directly for meat
  - ii) for young, mildly affected, and with health passport, may be sold to conventional herd
- Antibiotic treatments will persist in dairying

Behavior study: intent

- For dairying we consider managerial economics of farm-level antibiotics choices. Research reveals
  - human medicine doctors under strong pressure to prescribe antibiotics if any hope they will work for that patient (e.g., Linder et al. 2017)
  - given farming's complexity and span of decisions operators face, evidence that farmers generally may, be inattentive or even 'irrational,' mismanaging inputs (e.g., Perry et al. 2017)
- We want to understand why antibiotics are used and whether possibilities exist for behavioral (non-traditional) economics approaches to reduce demand

Query about on-farm use

Social best level, addressing antibiotic resistance risk

Private best level, say profit maximizing

Actual level ????

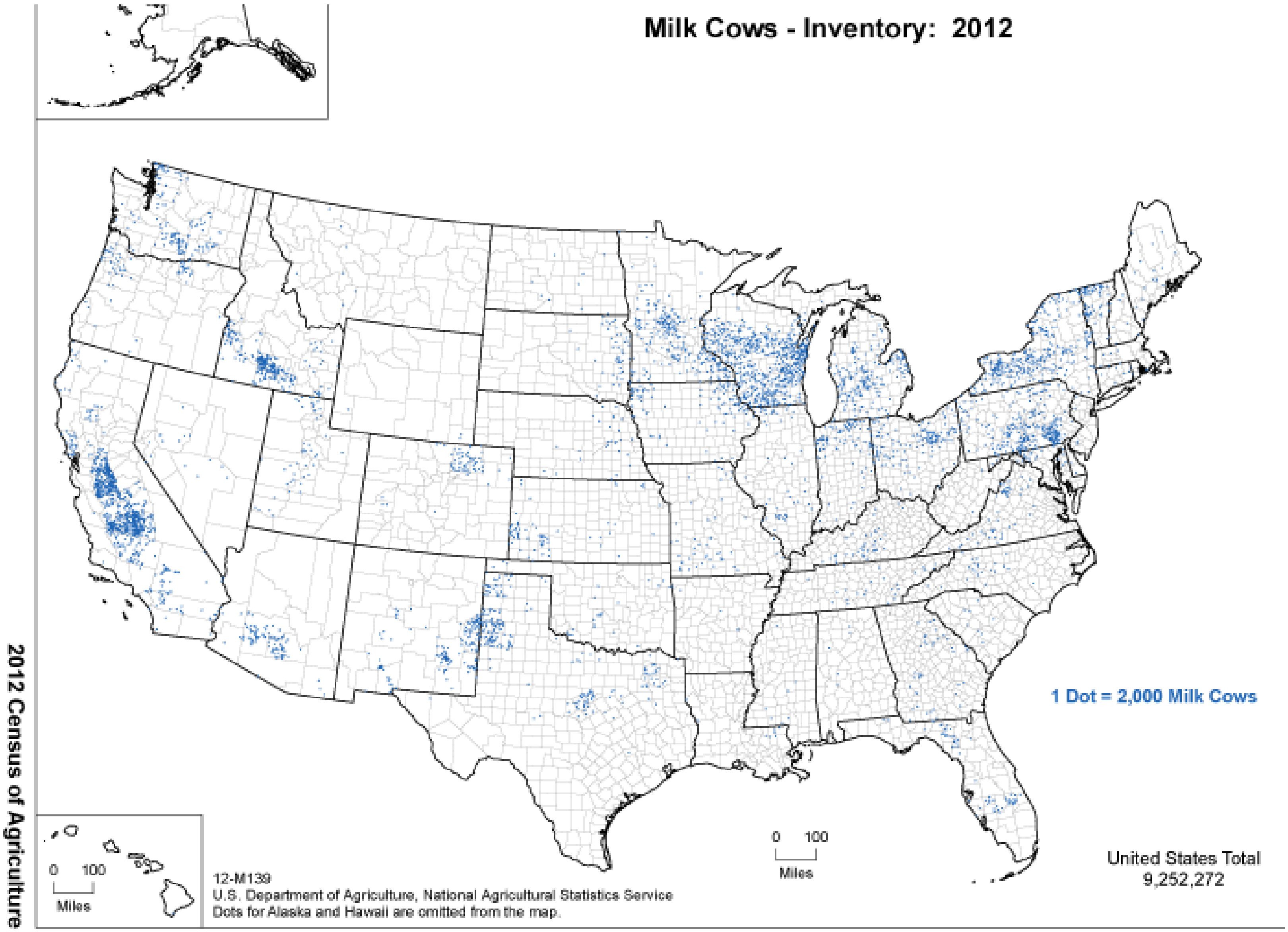
conventional, e.g., taxes, use regulations, markets

awareness, choice architecture, benchmarking

Amount of antibiotics used

If ???? true then a different set of instruments would be appropriate. Per EU currently

S a m p l e



Milk Cows - Inventory: 2012
1 Dot = 2,000 Milk Cows
United States Total
9,252,272
0 100
Miles
0 100
Miles
12-M139
U.S. Department of Agriculture, National Agricultural Statistics Service
Dots for Alaska and Hawaii are omitted from the map.
2012 Census of Agriculture

Survey

- Survey conducted by with support from Michigan State Univ. Elton R. Smith Endowment
- Overall intent to understand difficult business situation, but one section on antibiotics
- Paper and web versions, March-Sept. 2017, 21% response rate
- Purchased list + lists of state registered milking herds
- Antibiotics part asks
  – way used,
  – costs,
  – willingness to pay for treatment

All	688
WI	392
MN	171
MI	118

How used?

Treat a current infection?			
	<100 cows	100-499 cows	500+ cows
Yes	67.6%	73.9%	77.6%
Prevent infections (e.g., dry cow therapy)?			
Yes	60%	66%	76.3%
Keep cow's mastitis history records?			
Yes	60.5%	83.2%	93.2%
Separate mastitis-infected cows?			
Yes	27.1%	44.7%	75%
Total	330	153	76

Loss sources

Mean loss per cow per year if can't use	
Small	$1,834
Medium	$462
Large	$454
Average	$1,252

Median cost per case	
Diagnosis	$5
Therapeutics	$30
Non-saleable milk	$80
Veterinary service	$15
Labor	$15
Death loss	$34
Lost future milk	$200
Premature culling	$200
Lost future reproduction	$100

Data comparable to Rollin et al.

Therapeutics as share <5%

AMR ANTIMICROBIAL AGENTS AND RESISTANCE

Willingness to pay for antibiotics treatment: two points

1. Generally over-paying and so over-applying vs. profit impact

Cow not performing optimally. You isolate. There is a probability she can be cured by antibiotics, loss avoided if she is. What are you WTP?

Loss avoid probability	Loss: $100	$150	$200	$250
0.40	$103	$127	$117	$102
0.55	$137	$131	$122	$138
0.70	$154	$153	$166	$196
0.85	$169	$172	$196	$198

2. More probability sensitive than loss sensitive

Further evidence

Identify most & least IMPORTANT factors for your operation for managing mastitis	% most	% least
Increasing prob. treatment successful	59.8	12.8
Managing treatment cost	7.0	64.3
Reducing loss if cow infected & treatment effective	33.1	22.9
Total	513	507

Why emphasis on probability?

- A literature (Becker) on crime deterrence, trading off conviction probability with punishment size. Analog here is contraction probability vs. disease loss
- There is psychology literature that finds subjects focus on probability management over loss management
- But choosing actions to minimize prob $\times$ loss misses motives. Actions (e.g., antibiotics) reduce risk of *future* spread on that farm
- Risk averse farmers may play safe. Suggests cases for more biosecurity outreach & precise diagnostics

Antibiotics & contagion

- Farmers treat a particular cow in part because contagion is a concern
- Contagion occurs through shared implements + handling, + bacteria shed into environment
- Trade-off is *i*) cost now to stamp out an infection, vs. *ii*) potential uncertain continued cost in the future through early replacement, milk penalties, lower yields and further treatment costs
- We know little about how regulations to reduce treatment now will affect decision process and incentives to treat. But biosecurity to break transmission may lead growers to not over-apply

Some policy issues

- Modest antibiotics use tax likely ineffective. US VFD, linking with vet time cost, expertise, call for justification likely more effective
- Farmers may over-apply vs. profit maximizing choice (diagram), but this may be due to contagion concerns
- Question: will focused biosecurity training reduce grower antibiotics demand by reducing contagion risks?
- Farmers may be WTP for better diagnostics to increase success probability; diagnostics should reduce demand
- Need to understand roles of investment and scale in antibiotics demand

References

- Key N, WD McBride. 2014. Sub-therapeutic antibiotics and the efficiency of U.S. hog farms. Am. J. Agr. Econ. 96(3), 831-850.
- Linder JA. 2017. Influencing antibiotic prescribing behavior: Outpatient practices. Presentation, Feinberg Sch. Med., Northwestern Univ., Sept. 9.
- Perry E et al. 2017. Product formulation and glyphosate use: Confusion or rational behavior? Selected paper, AAEA Annual Meetings, Chicago, IL.
- Rollin E et al. 2015. The cost of clinical mastitis in the first 30 days of lactation: An economic modeling tool. Prev. Vet Med. 122(3), 257-262.

THANK YOU

How used, I

Written protocols to treat health veterinary conditions?					
Size	Cows			Organic	Total
	<100	100-499	500+		
Yes	50.4%	74.4%	88.2%	51.9%	60.9%
Total	355	153	76	52	636

Function of antibiotics		
Use, yes	Treat current infection	Prevention
87.7%	70.3%	62.7%

Fitted model, what do farmers worry about?

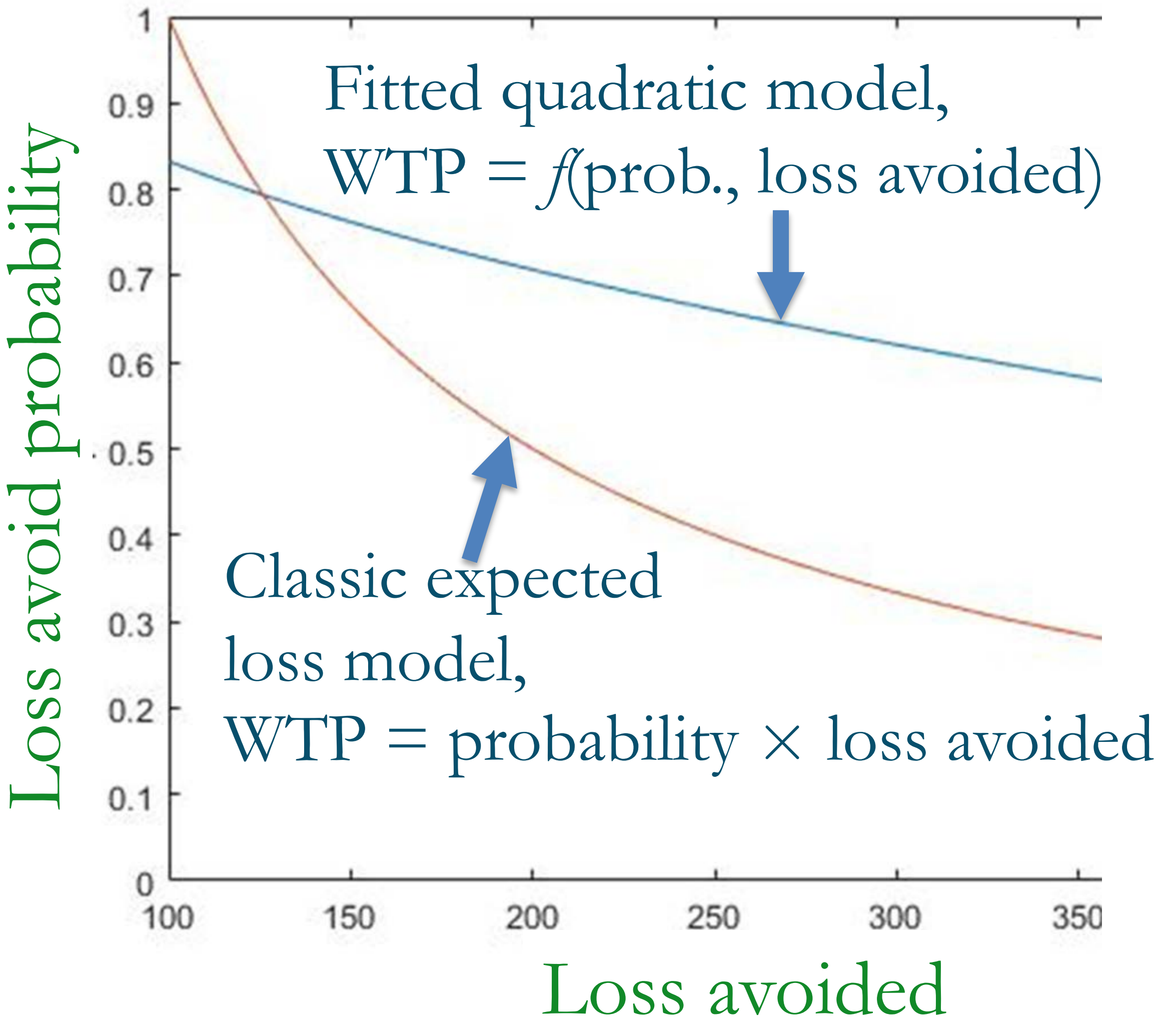


*Figure shows how probability and loss avoided trade off to keep WTP at $100

*Fitted curve shallower than expected loss curve

*Farmers are more keen to increase probability of loss avoided than to increase magnitude of loss avoided