Cost-Benefit Analysis of the U.S. National Animal Identification System (NAIS) in California

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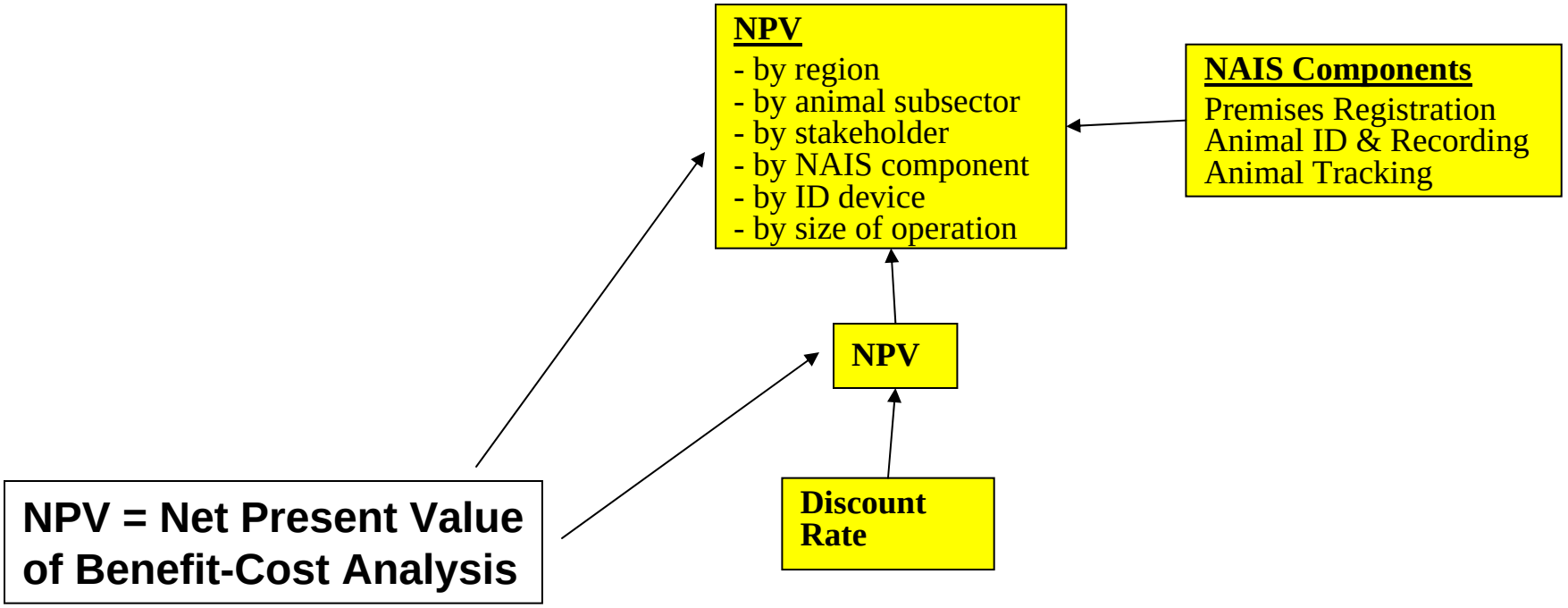
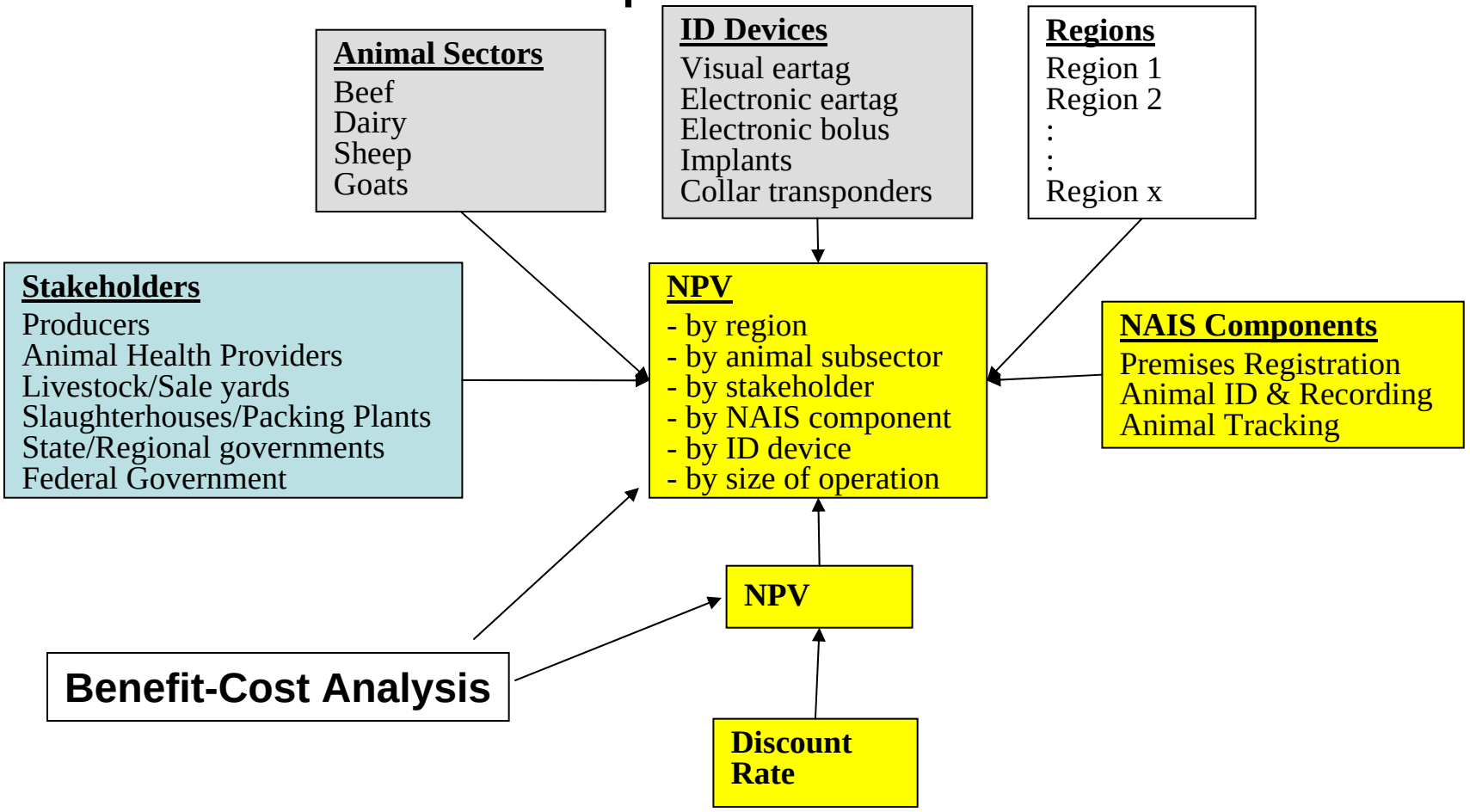
NAIS California Model

- Components: 1/5 -



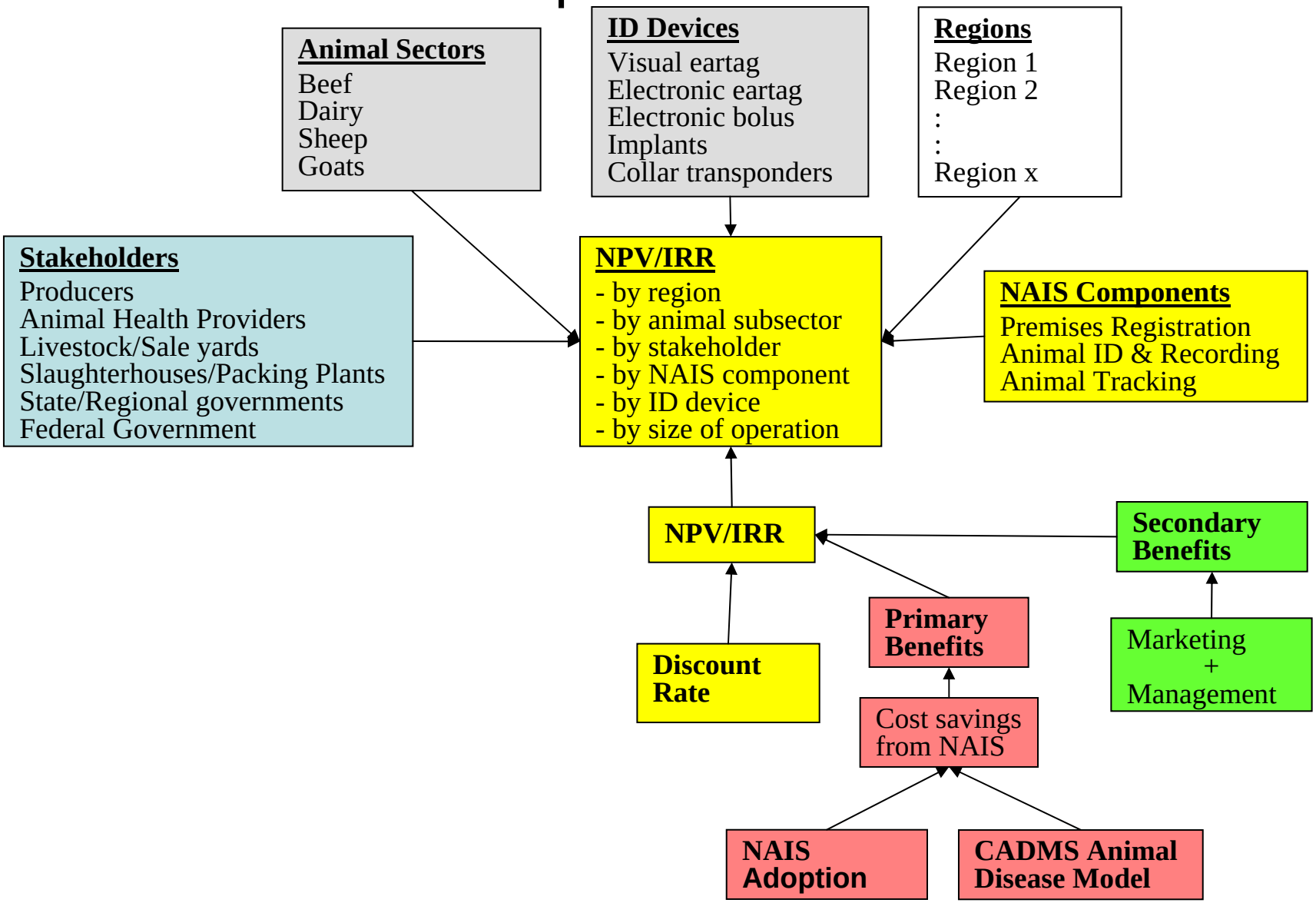
NAIS California Model

- Components: 2/5 -



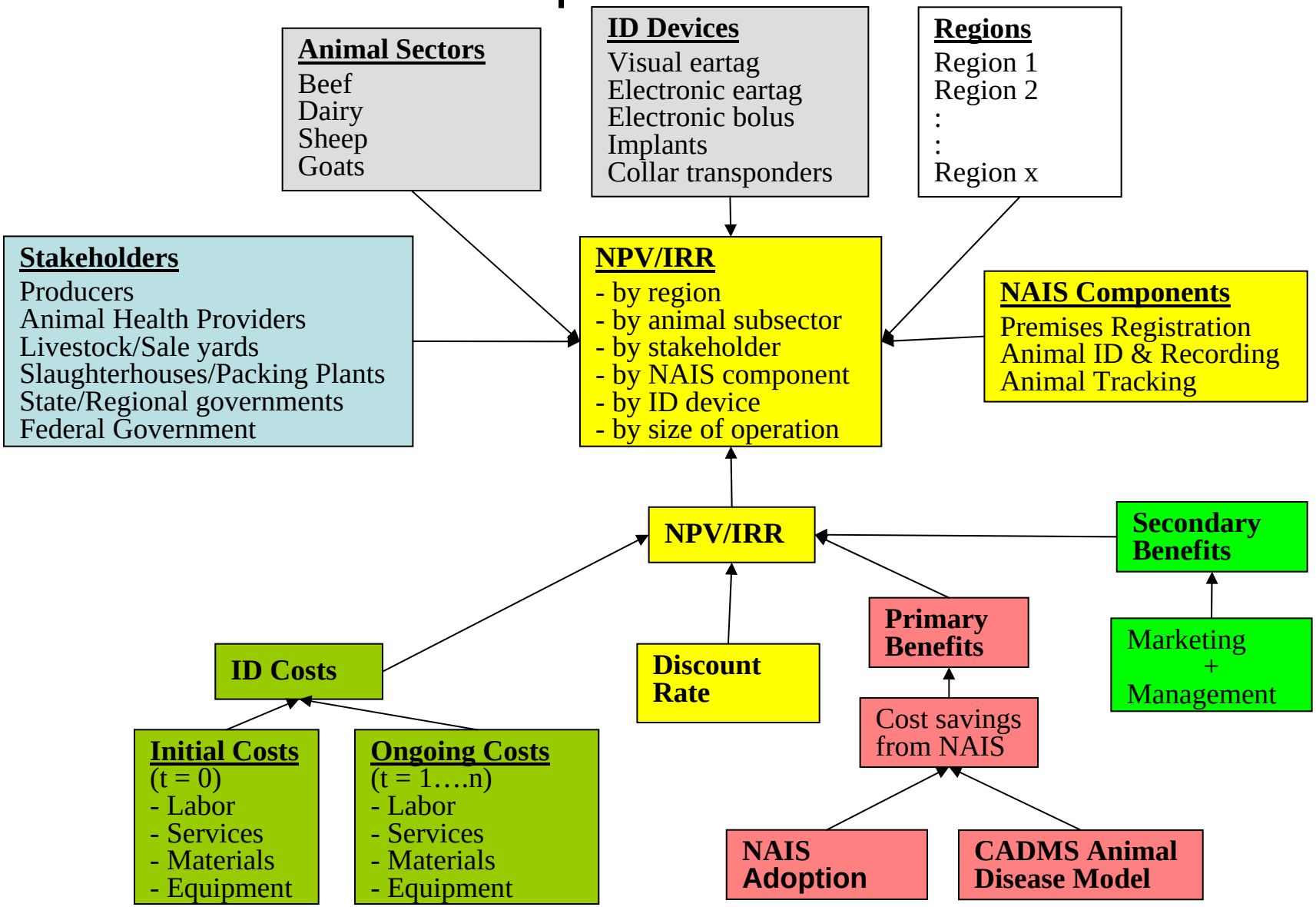
NAIS California Model

- Components: 3/5 -



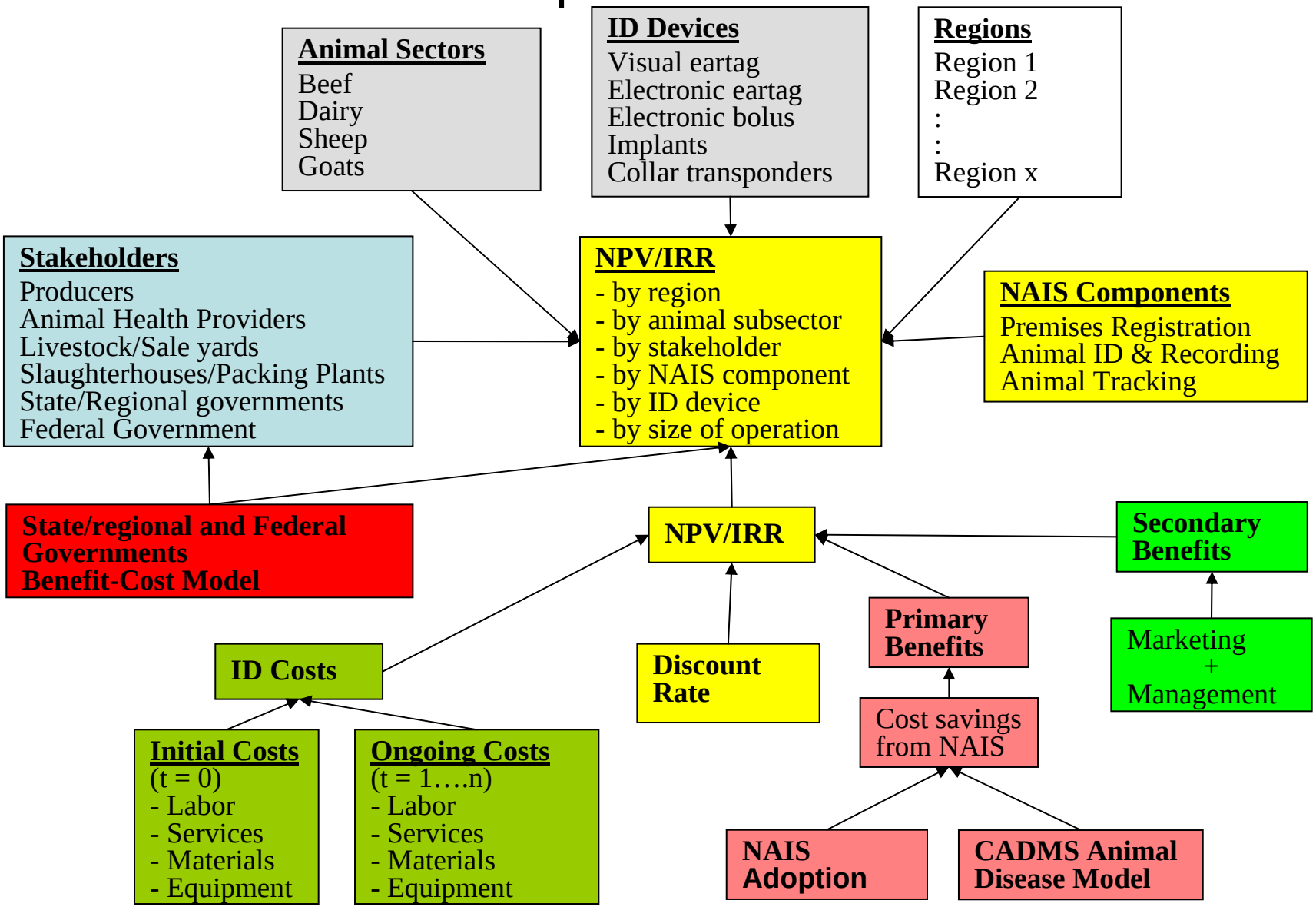
NAIS California Model

- Components: 4/5 -



NAIS California Model

- Components: 5/5 -

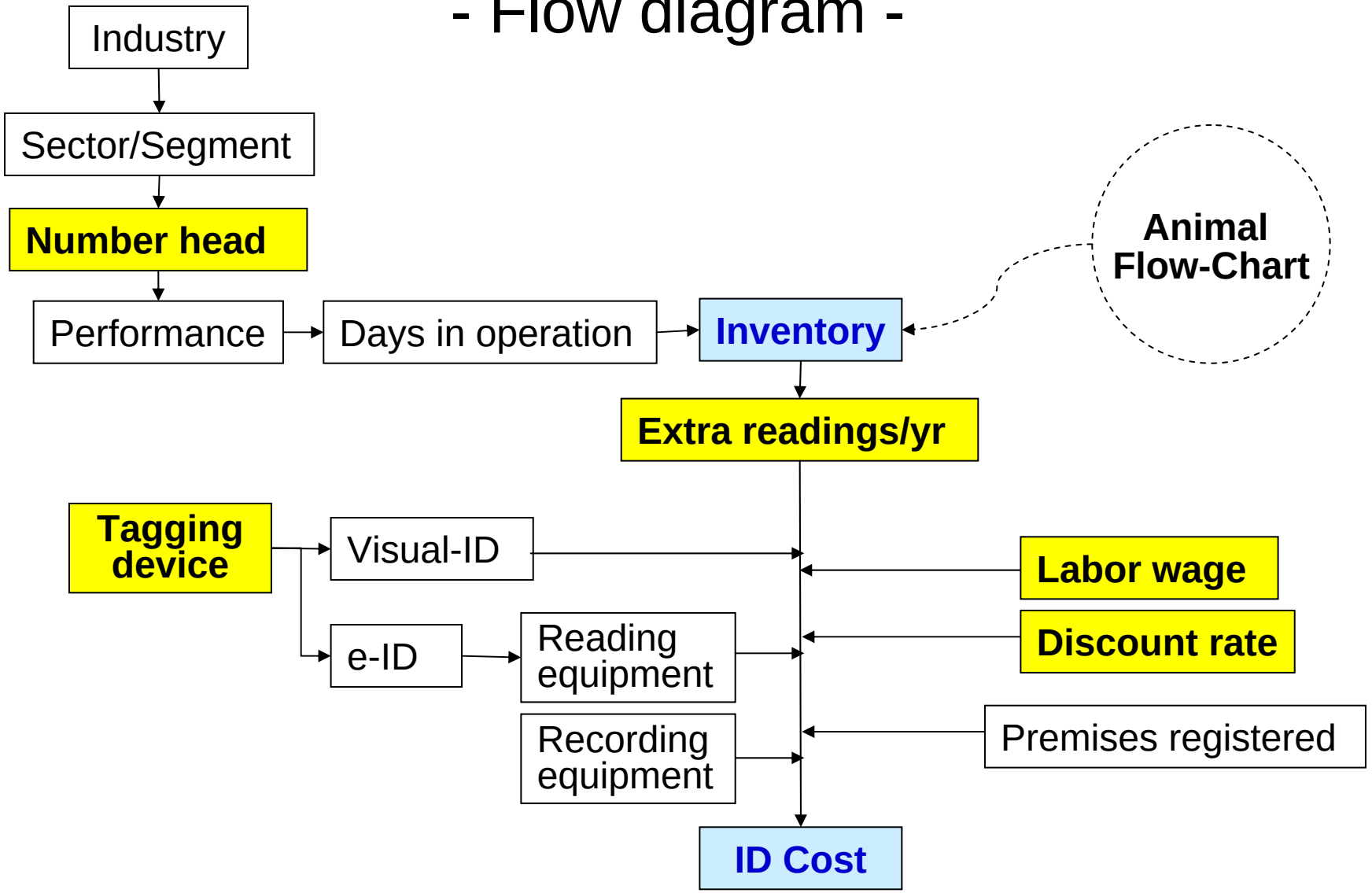


Costs of Animal ID

- We begin with the costs of animal ID systems because they are relatively easy to estimate.
- However, the model itself is large and complex and too unwieldy to demonstrate in a short time.
- Very briefly then…….

UCD-CDFA Cost-Benefit Model (v3.2)

- Flow diagram -



UCD-CDFA Cost-Benefit Model (v3.2)

- Cow-Calf Flow-Chart -

Beef cow-calf flow:

Go to Prod. systems
Beef cow-calf

Input

Bulls: 3
Lifespan (yr): 3,0%
6,7

Culled cows: 15
Culling rate: 15,0%
Input
Cows herd: 100
Pregnant heifers: 15

Calf rate: 87,0%
Calf crop: 87
Death rate: 2,0%
85

Pregnancy rate: 70,0%

Calves for sale: 64
Intended to sale: 74,5%
Saved for replacement: 25,5%
22

Open heifers: 30,0%
7
Heifers sold

Animals inventoried per yr:		
Bulls		3
Cows		100
Live calf crop		85
Saved heifers		22
Total inventory		**210**
Extra readings per yr:		
Bulls	1	3
Cows	2	200
Live calf crop	1	85
Saved heifers	1	22
Total readings	5	
Readings/farm		**310**

Ave readings (/animal/yr)	1,5
Animals/reading/yr	42

Input

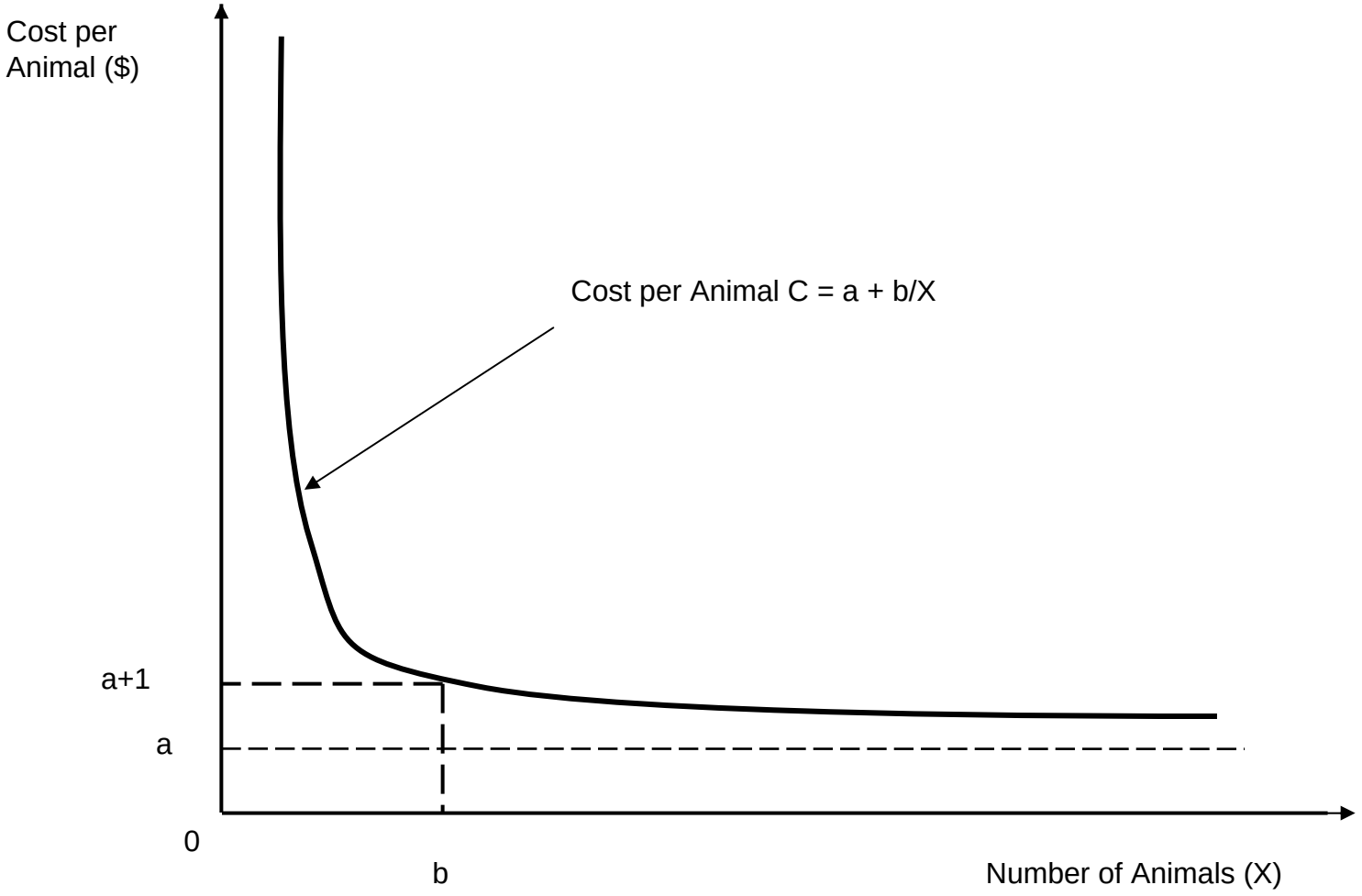
Output: Number of animals to be tagged

Output: Labor cost for readings

Cost Model Results 1

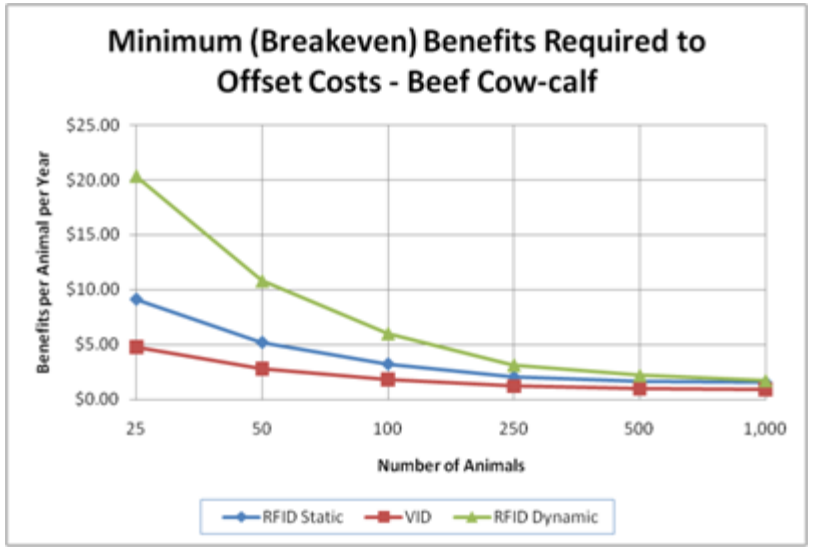
- Costs are directly and inversely proportional to size of operation
- Costs prohibitively high for small producers due to expense of readers, software and computers
- Costs of recording and reporting are minor
- Visual ID is cheaper but burdensome due to lack of electronic ease of data collection and reporting.

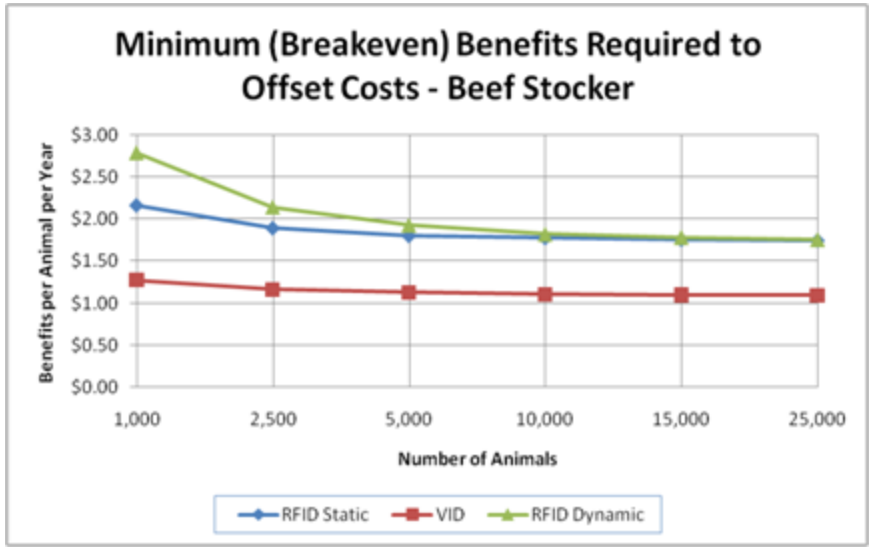
Costs of Animal ID – Cost Function

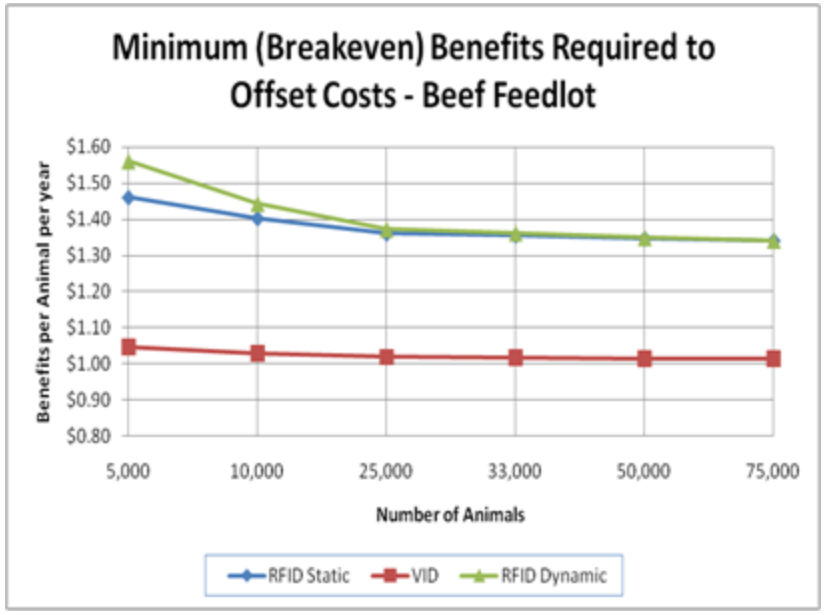


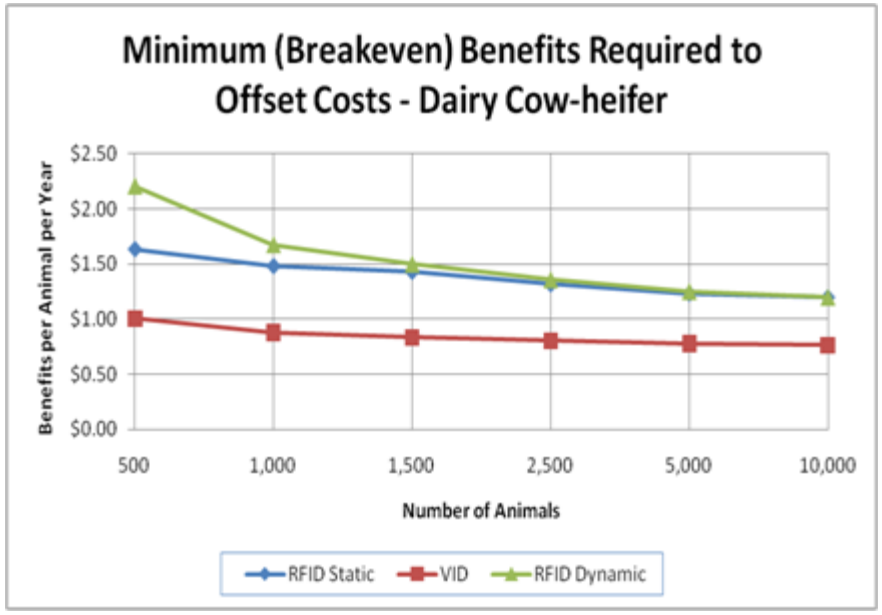
Cost Model Results 2

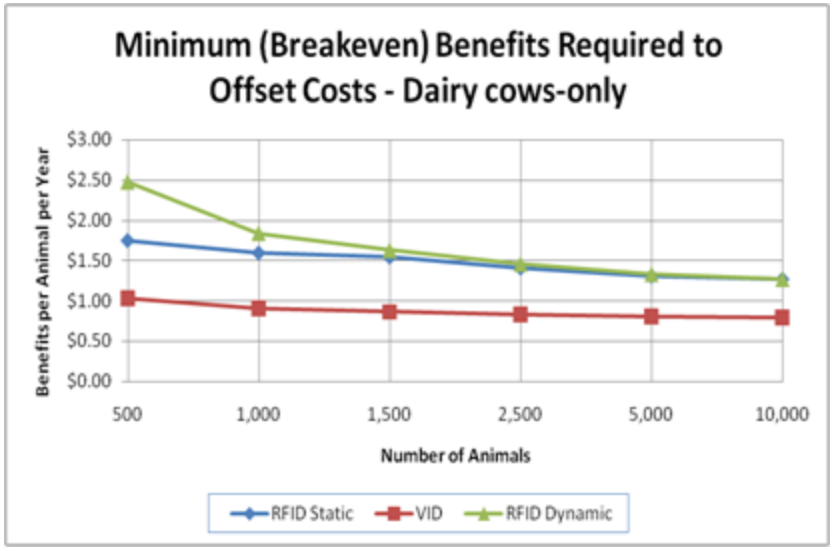
- Labor costs are much lower than past concerns have indicated
- Sensitivity analysis shows that material and capital equipment costs are main reason for variance in costs
- Cost reduction strategies examined show that costs for small and medium sized operations can be significantly reduced

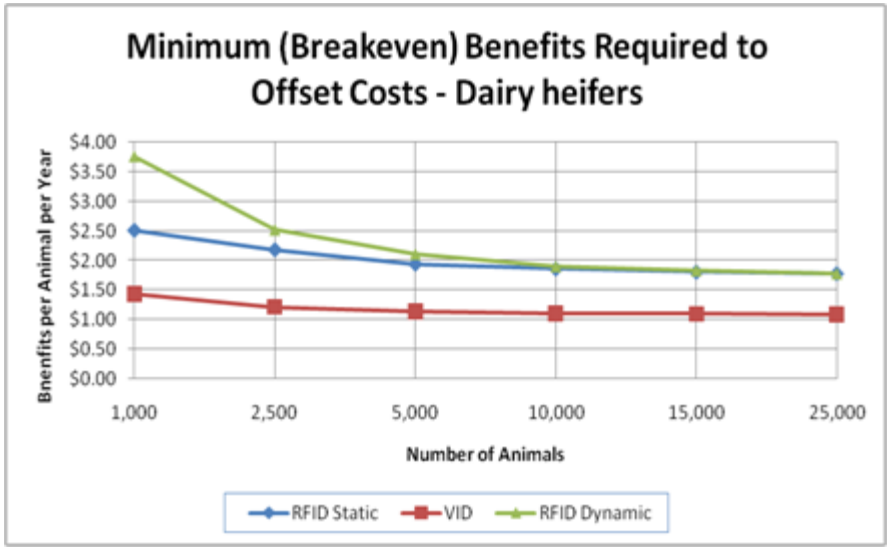

Minimum (Breakeven) Benefits Required to Offset Costs - Beef Cow-calf
Benefits per Animal per Year
$25.00
$20.00
$15.00
$10.00
$5.00
$0.00
25
50
100
250
500
1,000
Number of Animals
RFID Static
VID
RFID Dynamic

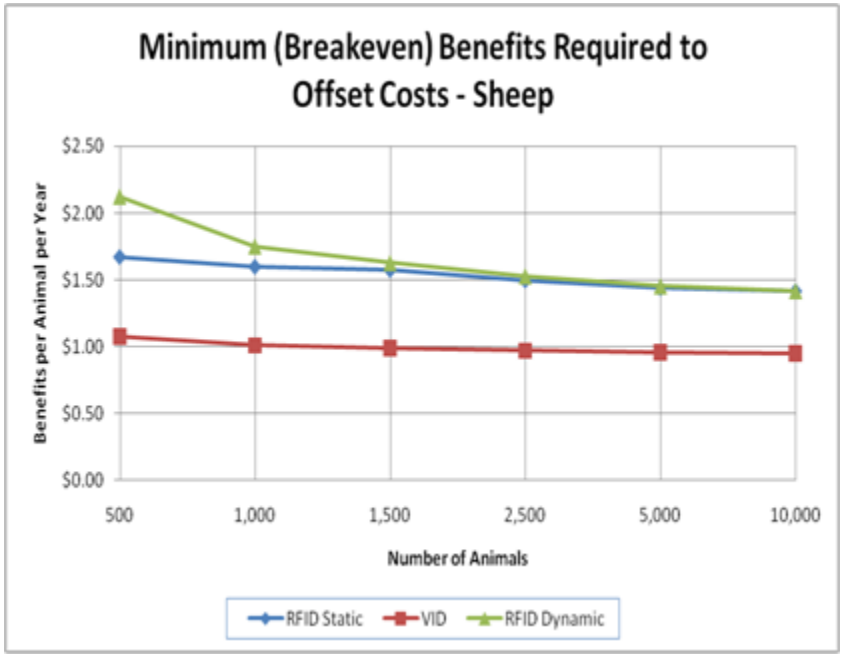

Minimum (Breakeven) Benefits Required to Offset Costs - Beef Stocker
Benefits per Animal per Year
$3.00
$2.50
$2.00
$1.50
$1.00
$0.50
$0.00
1,000
2,500
5,000
10,000
15,000
25,000
Number of Animals
RFID Static
VID
RFID Dynamic

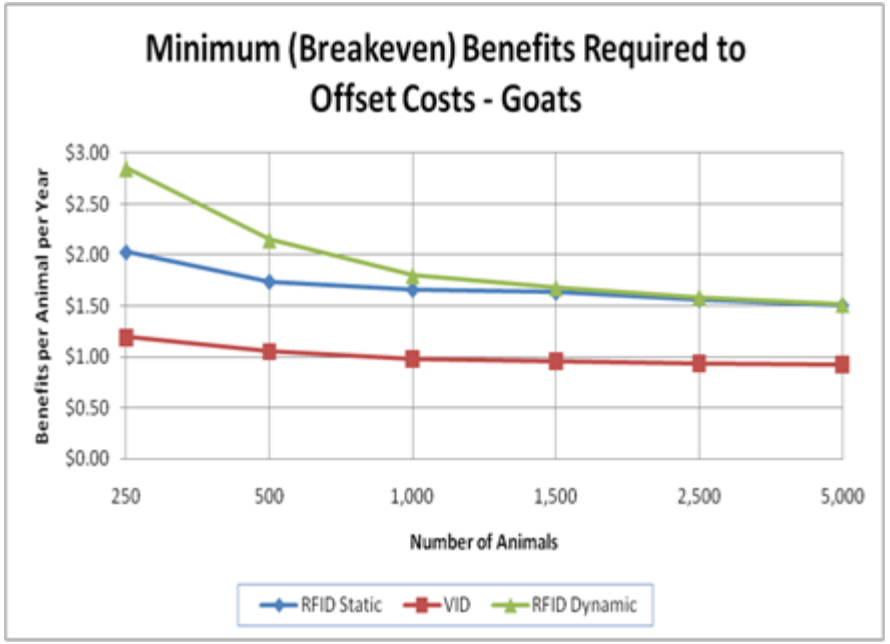

Minimum (Breakeven) Benefits Required to Offset Costs - Beef Feedlot
Benefits per Animal per year
$1.60
$1.50
$1.40
$1.30
$1.20
$1.10
$1.00
$0.90
$0.80
5,000
10,000
25,000
33,000
50,000
75,000
Number of Animals
RFID Static
VID
RFID Dynamic


Minimum (Breakeven) Benefits Required to Offset Costs - Dairy Cow-heifer
Benefits per Animal per Year
$2.50
$2.00
$1.50
$1.00
$0.50
$0.00
500
1,000
1,500
2,500
5,000
10,000
Number of Animals
RFID Static
VID
RFID Dynamic


Minimum (Breakeven) Benefits Required to Offset Costs - Dairy cows-only
Benefits per Animal per Year
$3.00
$2.50
$2.00
$1.50
$1.00
$0.50
$0.00
500
1,000
1,500
2,500
5,000
10,000
Number of Animals
RFID Static
VID
RFID Dynamic


Minimum (Breakeven) Benefits Required to Offset Costs - Dairy heifers
Bnenfits per Animal per Year
$4.00
$3.50
$3.00
$2.50
$2.00
$1.50
$1.00
$0.50
$0.00
1,000
2,500
5,000
10,000
15,000
25,000
Number of Animals
RFID Static
VID
RFID Dynamic


Minimum (Breakeven) Benefits Required to Offset Costs - Sheep
Benefits per Animal per Year
$2.50
$2.00
$1.50
$1.00
$0.50
$0.00
500
1,000
1,500
2,500
5,000
10,000
Number of Animals
RFID Static
VID
RFID Dynamic


Minimum (Breakeven) Benefits Required to Offset Costs - Goats
Benefits per Animal per Year
$3.00
$2.50
$2.00
$1.50
$1.00
$0.50
$0.00
250
500
1,000
1,500
2,500
5,000
Number of Animals
RFID Static
VID
RFID Dynamic

Benefits of an Animal ID System

- Maintain distinction between primary and secondary benefits
- Primary benefits are main aim of NAIS – establish system of animal ID and traceability to improve abilities to identify and isolate exposure to outbreaks of serious disease
- Secondary benefits (management and marketing functions) also important, but should not be confused with primary benefits

Primary Benefits

- Lack of information – especially easily quantifiable information in $ terms
- Used hypothetical example of FMD outbreak to demonstrate:
  - High costs of animal disease
  - Potential benefits of animal ID system
- Results showed difficulties due to:
  - Specific to particular disease in a particular location
  - Probability of disease is small but unpredictable
  - **Dependent on level of NAIS participation**

Benefits - Major Findings

- Benefits of an animal ID system accruing to benefactors depend IMPORTANTLY on level of participation in the system.
- Thus, impossible to evaluate benefits of NAIS without making STRONG assumptions about levels of participation.

Characterization of Animal ID System

- We use concepts of network effects (externalities) and critical mass to demonstrate:
  - Growth in NAIS adoption and participation
  - Critical mass points
  - Benefactors of NAIS
    - Participants
    - Non-participants
    - State
    - Society

Primary Benefits – Major Findings

- Primary Benefits increase as participation increases
- BUT, primary benefits accrue to ALL producers as system grows, regardless of whether they participate or not
- Thus, a major problem is FREE-RIDERS
- This means that all incentives to adopt an animal ID system rest almost entirely on the Secondary Benefits.

Secondary Benefits

- Secondary Benefits are incredibly difficult to estimate because they vary depending on:
  - The type of animal operation
  - The size of the operation
  - The needs of the operation

Estimating the Benefits of an Animal ID System

- Total Value of adopting an animal ID system is:

$$V = Bp + Bs$$

where V = total value

Bp = Primary benefits

Bs = Secondary benefits

Estimating the Benefits of an Animal ID System

- For initial adopters, there are no primary benefits, and Bp = 0 initially
- Thus initial adopters will only adopt for secondary benefits (Bs)
- Assuming that Bs = cost of the system (C) for initial adopters, then Bp = V–Bs = V – C
- We know the cost (C)…we need to calculate value (V)

Estimating the Benefits of an Animal ID System

- Varian (1998) generates a market equilibrium for goods exhibiting network externalities, given by:

$$P = n(N-n)$$

where P = price people are willing to pay for good

n = number of current users in the system

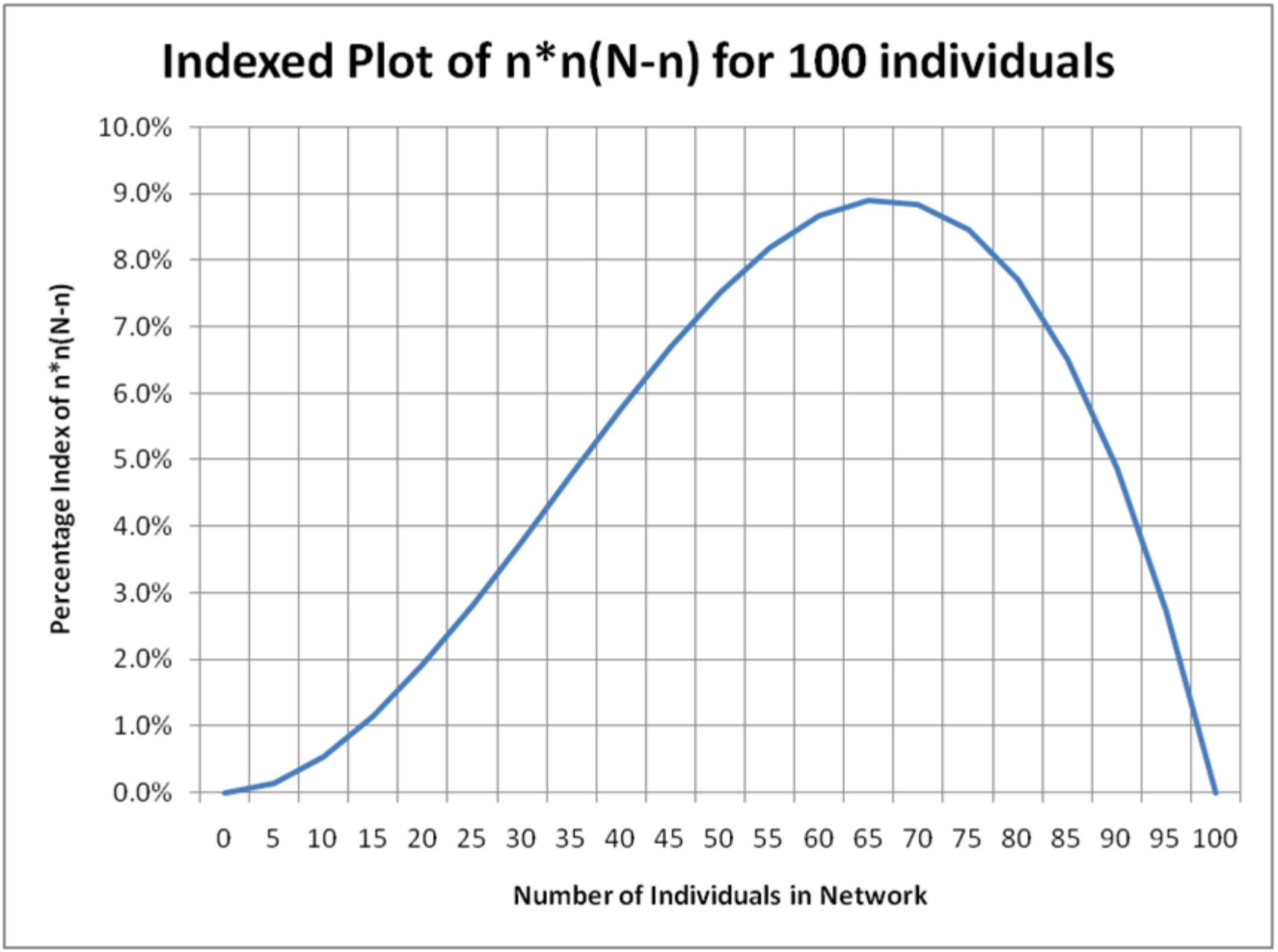
N = total number of potential users

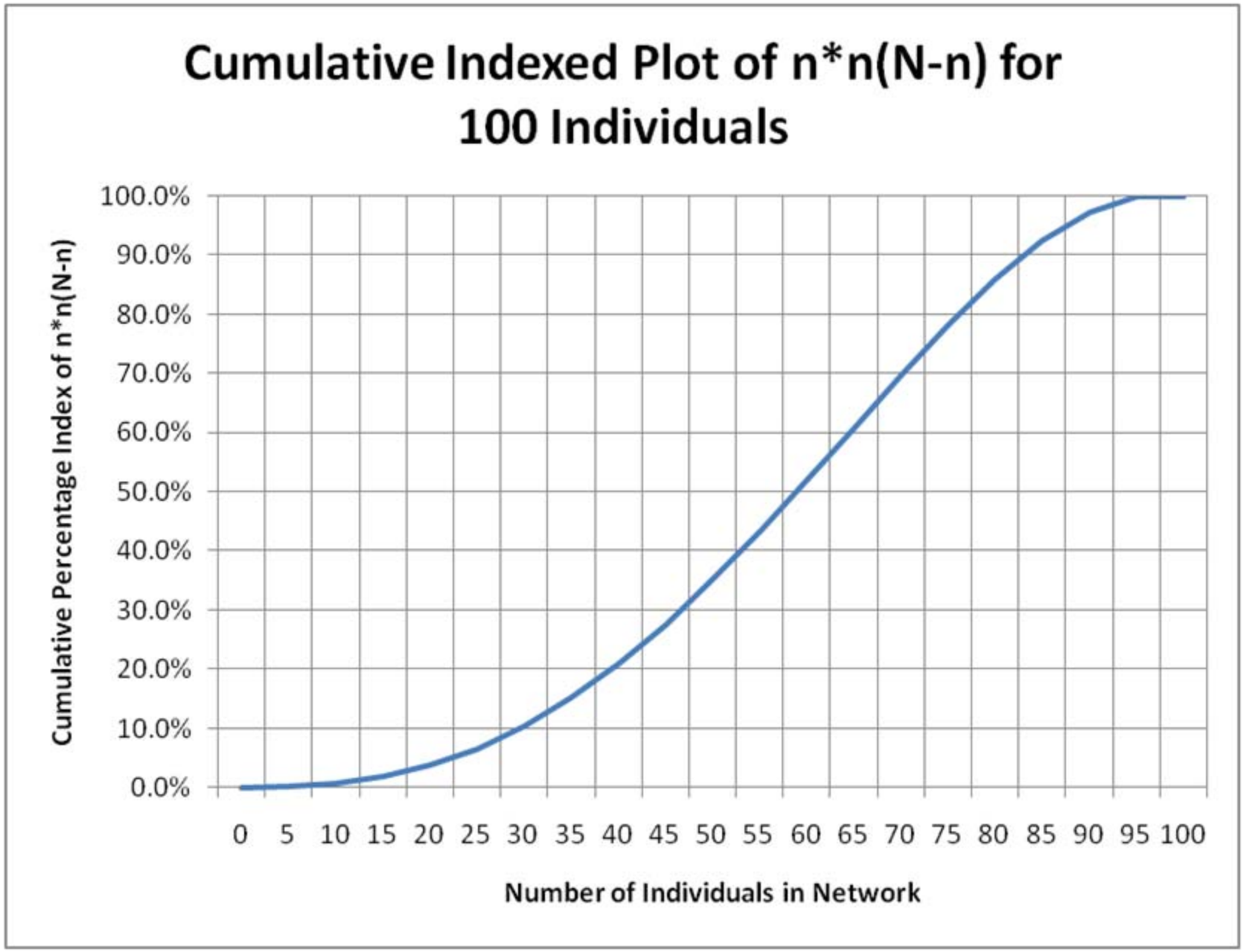
- Therefore the value of system for any n users is given by:

$$Vn = P*n = n*n(N-n)$$

Estimating the Benefits of an Animal ID System

- Now the function P*n = n*n(N-n) actually describes how the system grows, so if we index it, we can use the index to describe how the value of the system grows.


Indexed Plot of n*n(N-n) for 100 individuals
Percentage Index of n*n(N-n)
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
Number of Individuals in Network


Cumulative Indexed Plot of n*n(N-n) for 100 Individuals
Cumulative Percentage Index of n*n(N-n)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
Number of Individuals in Network

Estimating the Benefits of an Animal ID System

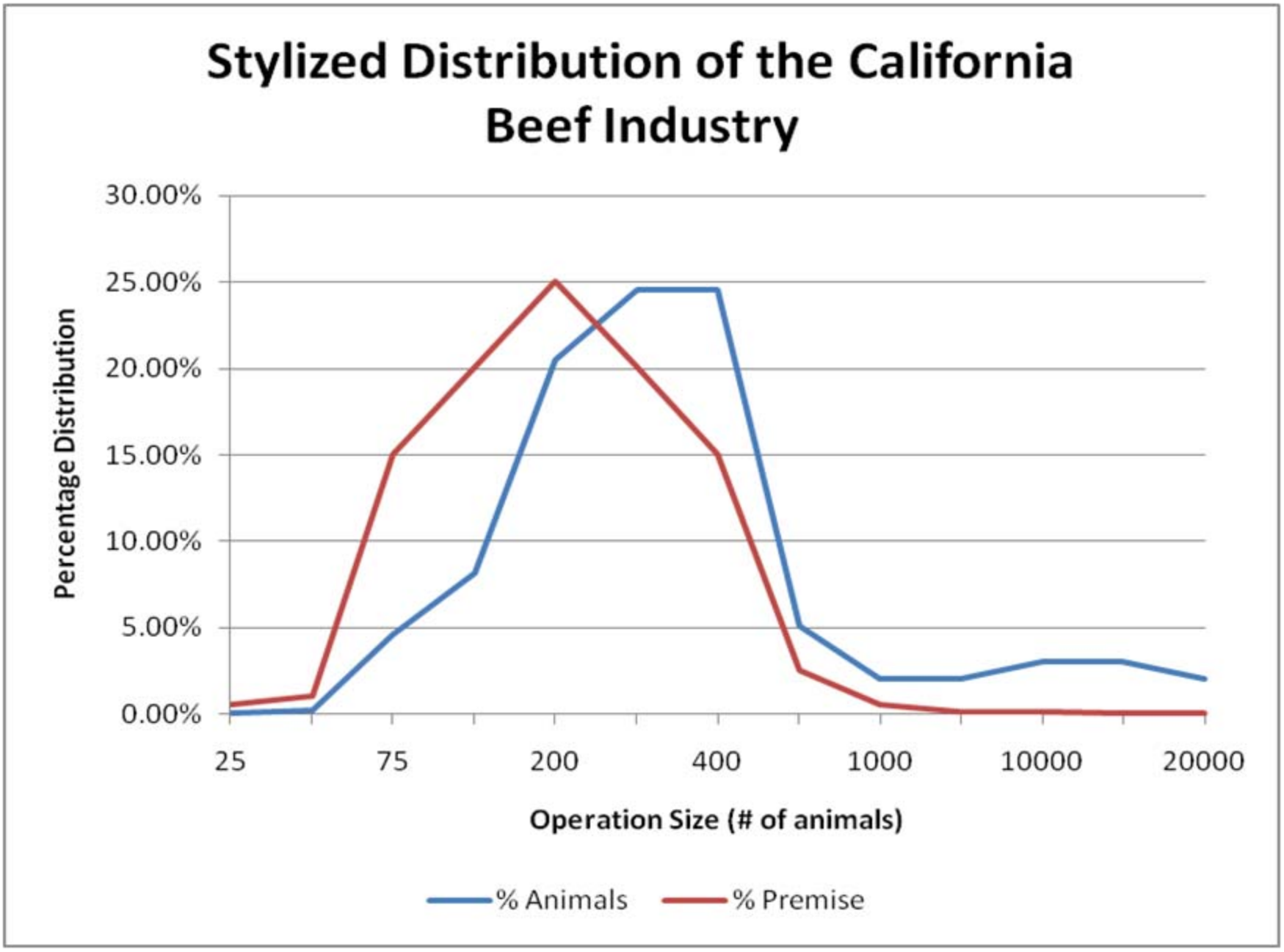
- For the first adopters of an animal ID system:
  - There are no primary benefits
  - Therefore adoption is based on secondary benefits only
  - Since there are substantial economies of size associated with animal ID systems then the first to adopt will be the largest operations for whom costs are lowest.

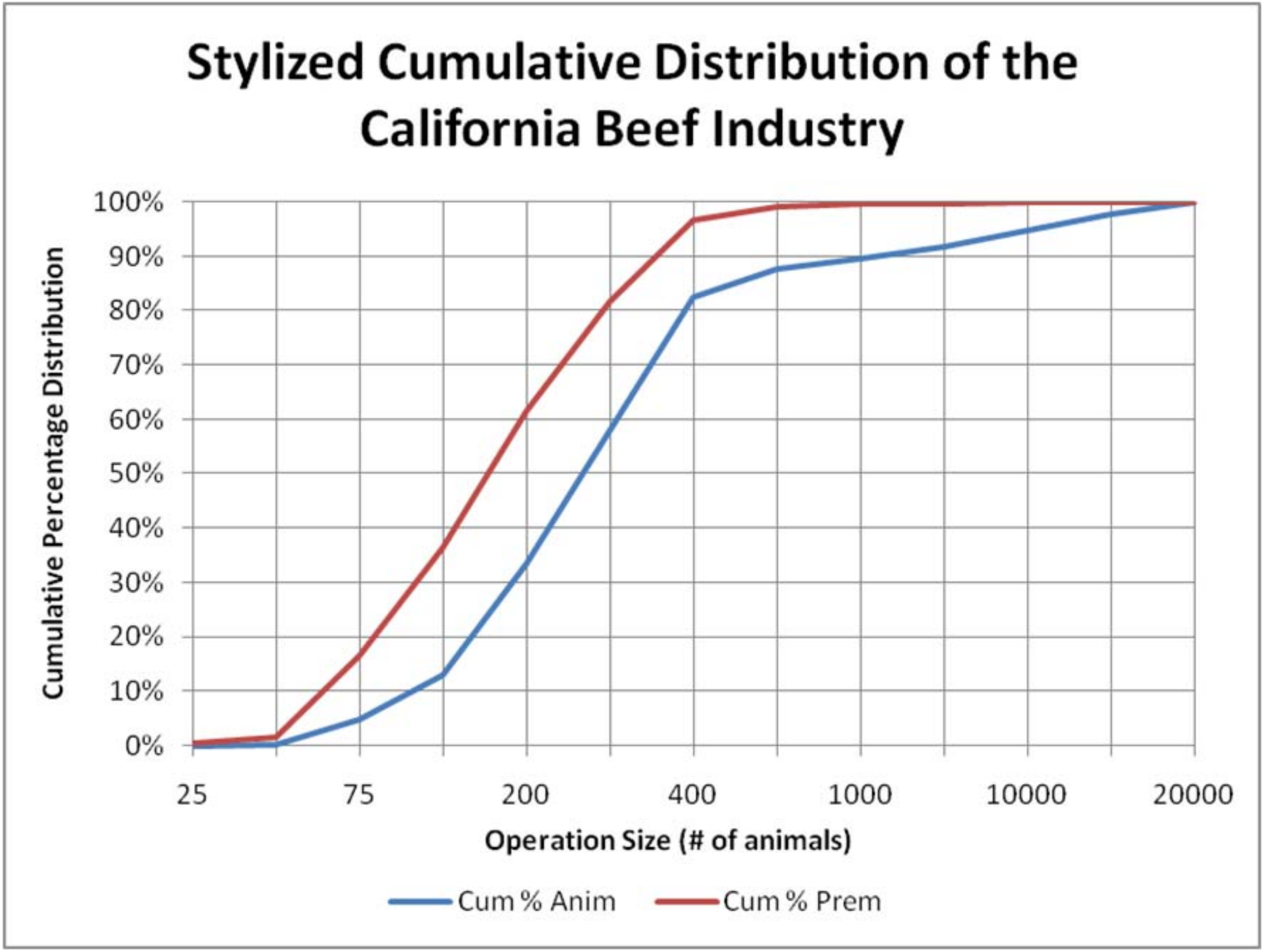
Estimating the Benefits of an Animal ID System

- Therefore we must look at a rank ordered distribution of an animal industry
- For example, we normally look at industry distributions going from small to large……..

Distribution of the California Beef Industry, 2007

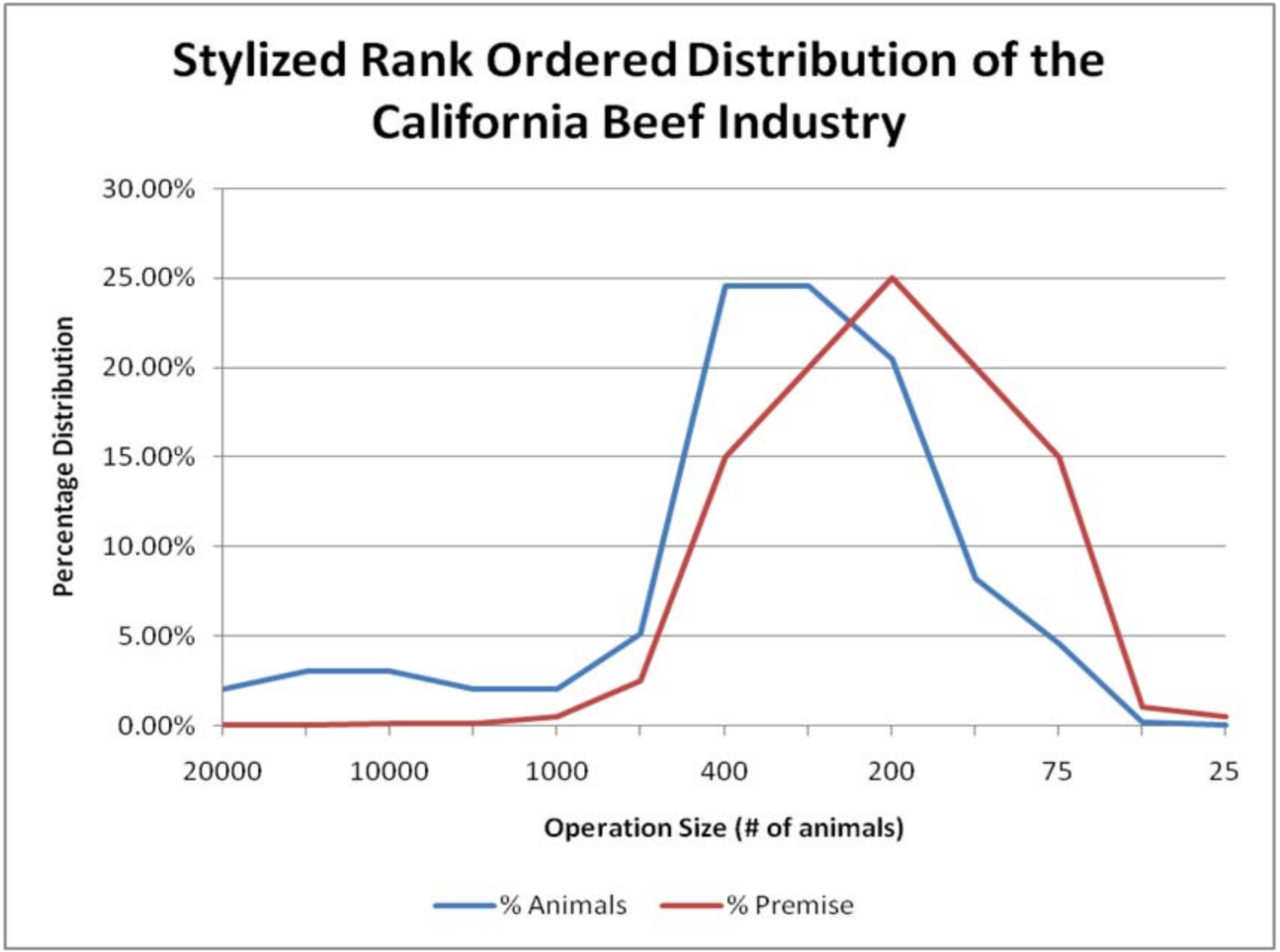
# Cattle	% Premises	% Cattle	# Premises	# Cattle
1 to 99	80.00%	20.00%	12,000	1,100,000
100 to 499	18.00%	24.00%	2,700	1,320,000
500+	2.00%	56.00%	300	3,080,00
	100.00%	100.00%	15,000	5,500,000


Stylized Distribution of the California Beef Industry
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Percentage Distribution
25
75
200
400
1000
10000
20000
Operation Size (# of animals)
% Animals
% Premise

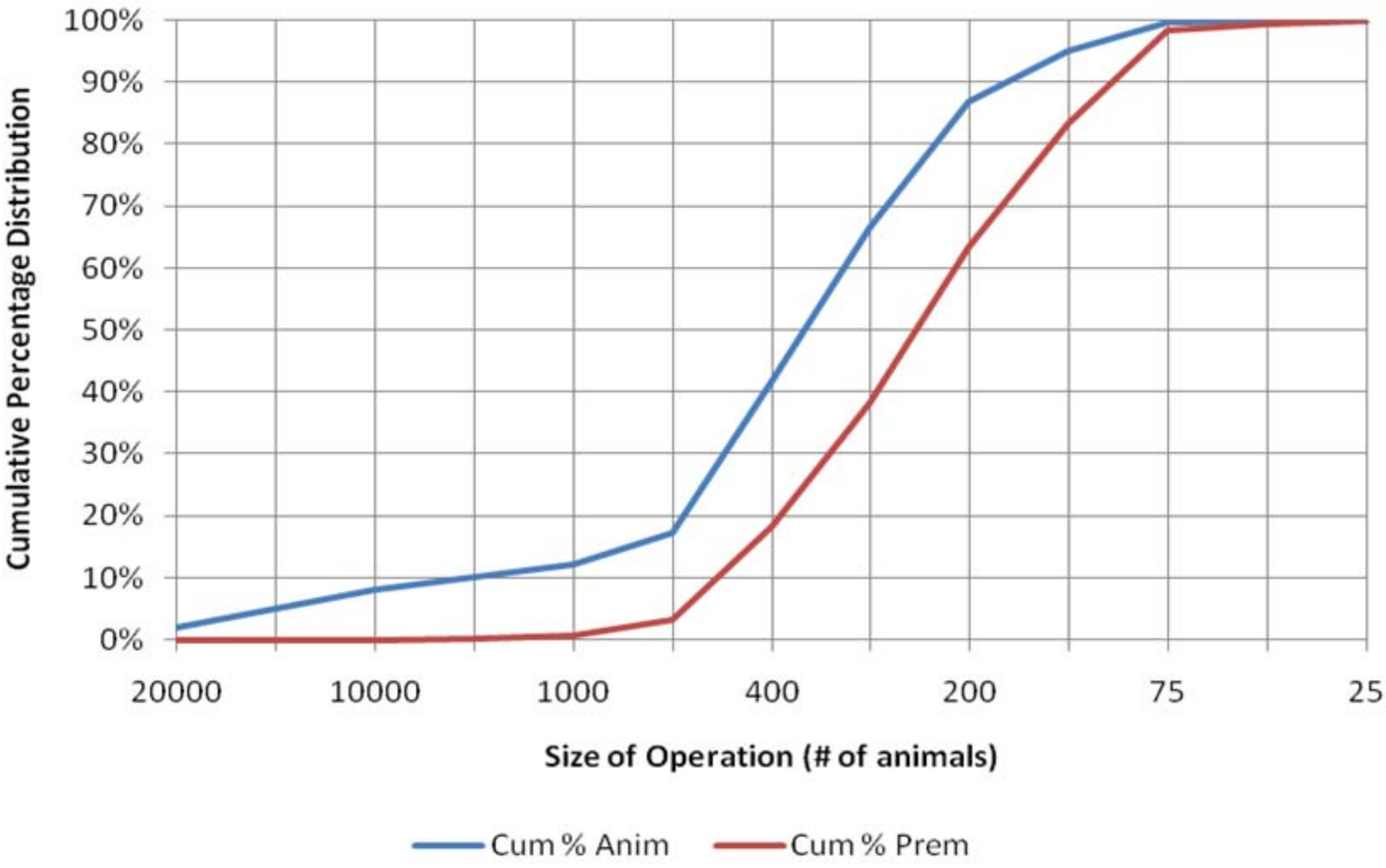

Stylized Cumulative Distribution of the California Beef Industry
Cumulative Percentage Distribution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
25
75
200
400
1000
10000
20000
Operation Size (# of animals)
Cum % Anim
Cum % Prem

Estimating the Benefits of an Animal ID System

- But since the largest operations have the lowest cost, they are most likely to adopt an animal ID system first.
- Therefore, we need to rank order the industry from large to small….


Stylized Rank Ordered Distribution of the California Beef Industry
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Percentage Distribution
20000
10000
1000
400
200
75
25
Operation Size (# of animals)
% Animals
% Premise

Stylized Rank Ordered Cumulative Distribution of the California Beef Industry



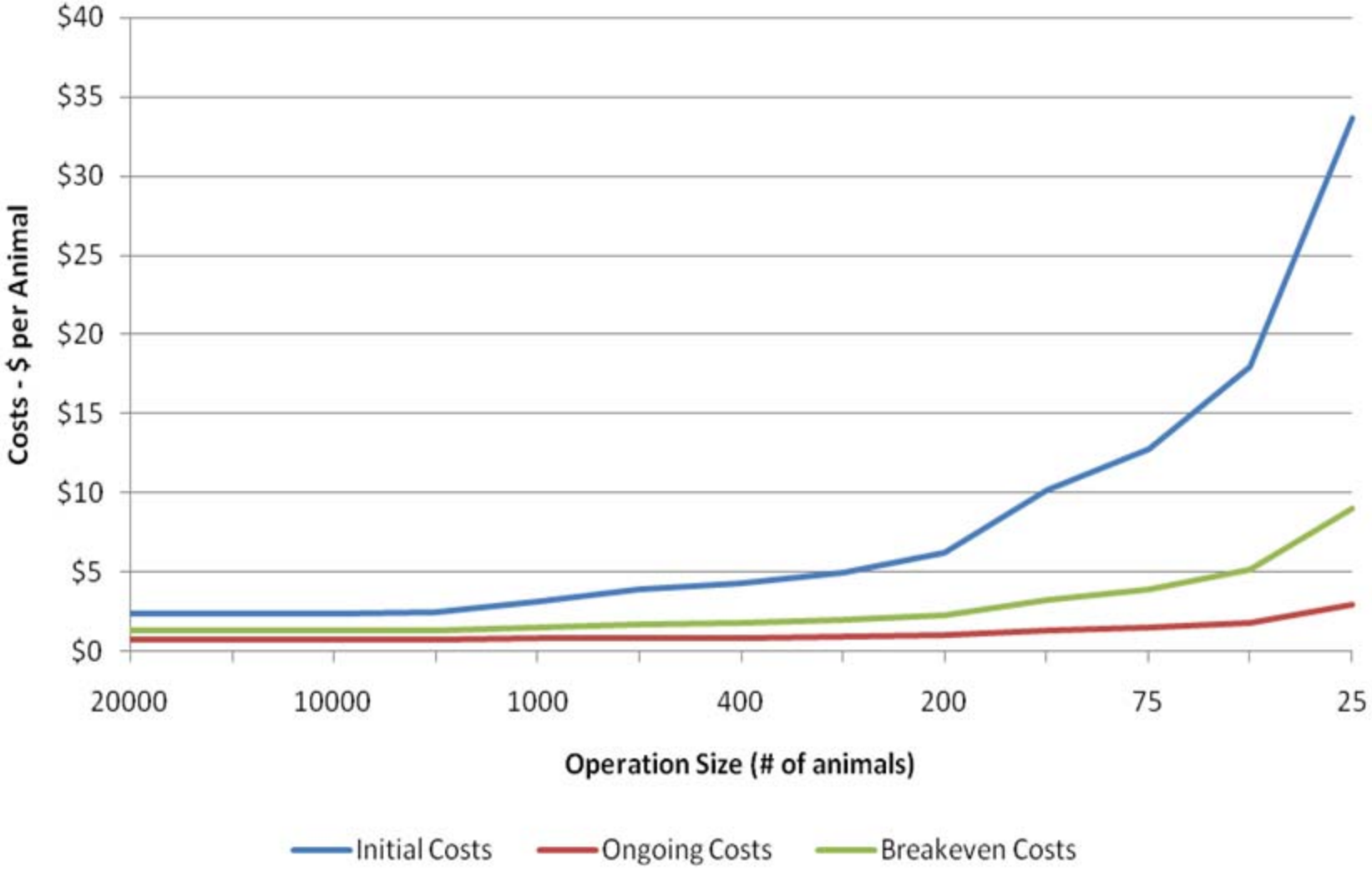
Estimating the Benefits of an Animal ID System

- Now, let's look at the costs of an animal ID system associated with each of the size groups…..
- Remember, we estimated the costs for all sizes of operation of the form:

$$C = a + b/X$$

(as X - the number of animals - gets larger, C - the cost - gets smaller)

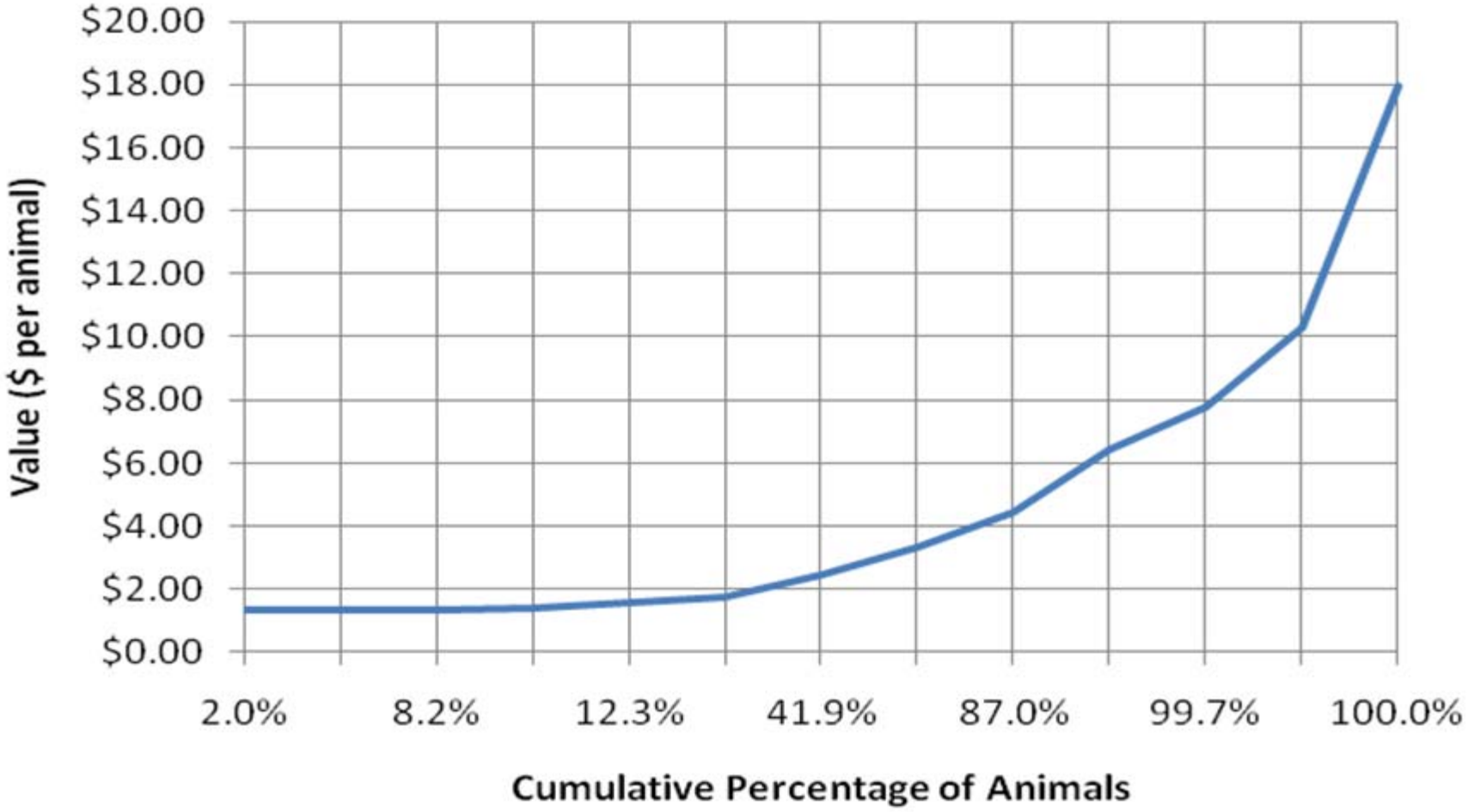
Initial, Ongoing and Breakeven Costs for an Animal ID system for the California Beef Industry

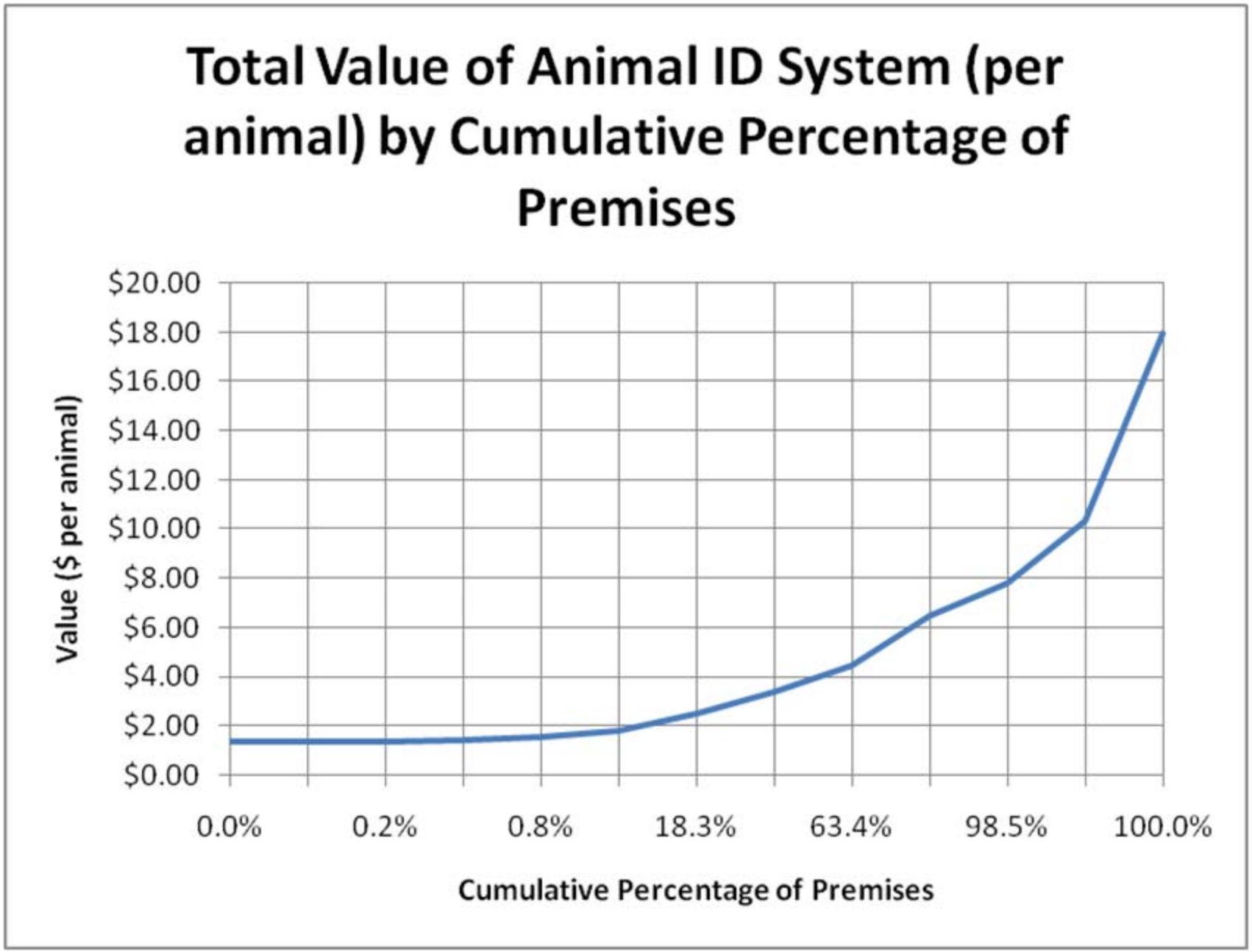


Estimating the Benefits of an Animal ID System

- Ongoing and breakeven costs are discounted at 7% over 10 years.
- So if we apply our growth in value index to breakeven costs, we can map the growth in total value of animal ID systems…

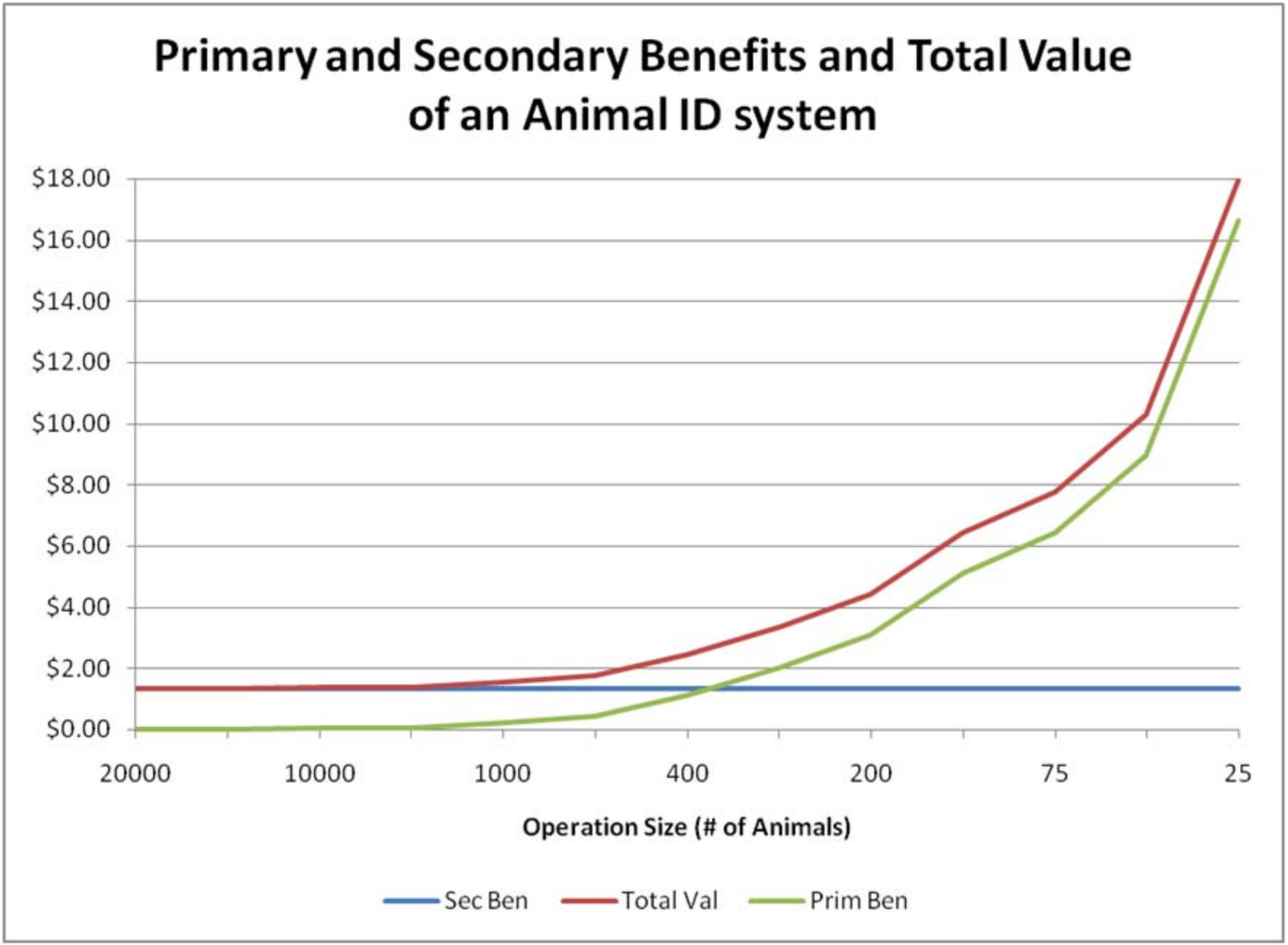
Total Value of Animal ID System (per animal) by Cumulative Percentage of Total Animals




Total Value of Animal ID System (per animal) by Cumulative Percentage of Premises
Value ($ per animal)
$20.00
$18.00
$16.00
$14.00
$12.00
$10.00
$8.00
$6.00
$4.00
$2.00
$0.00
0.0%
0.2%
0.8%
18.3%
63.4%
98.5%
100.0%
Cumulative Percentage of Premises

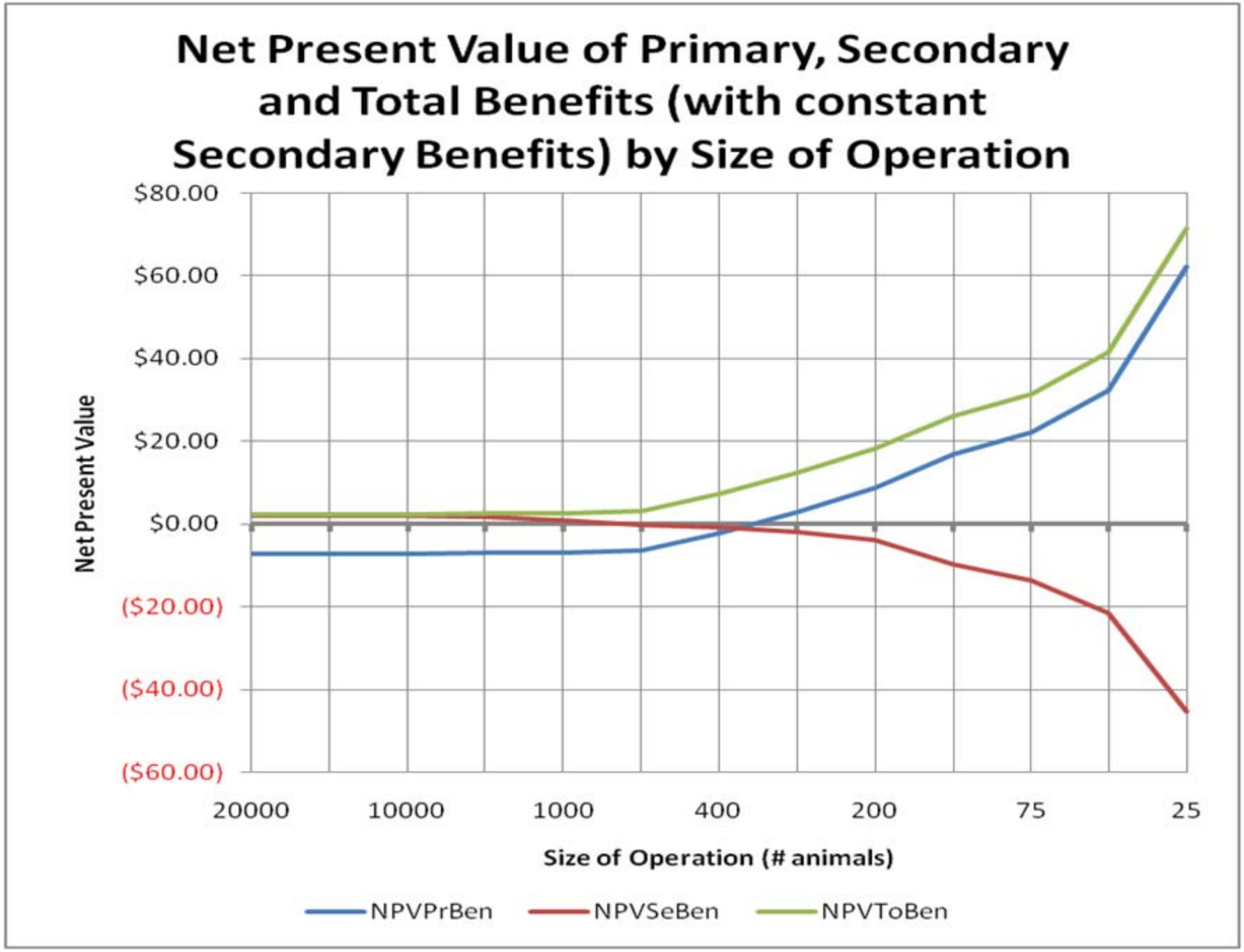
Estimating the Benefits of an Animal ID System

- So…
  - Secondary Benefits are constant and assumed to be equal to the lowest cost of the system for this industry
  - Thus, primary benefits are the difference between total value and the secondary benefits
  - i.e. $Bp = V - Bs$


Primary and Secondary Benefits and Total Value of an Animal ID system
$18.00
$16.00
$14.00
$12.00
$10.00
$8.00
$6.00
$4.00
$2.00
$0.00
20000
10000
1000
400
200
75
25
Operation Size (# of Animals)
Sec Ben
Total Val
Prim Ben

Estimating the Benefits of an Animal ID System

- So now we have primary and secondary benefits, total value and initial and ongoing (average annual) costs associated with an animal ID system for each size group of the industry.
- These values allow us to calculate Net Present Values for primary and secondary benefits and the NPV of the system for each size group.

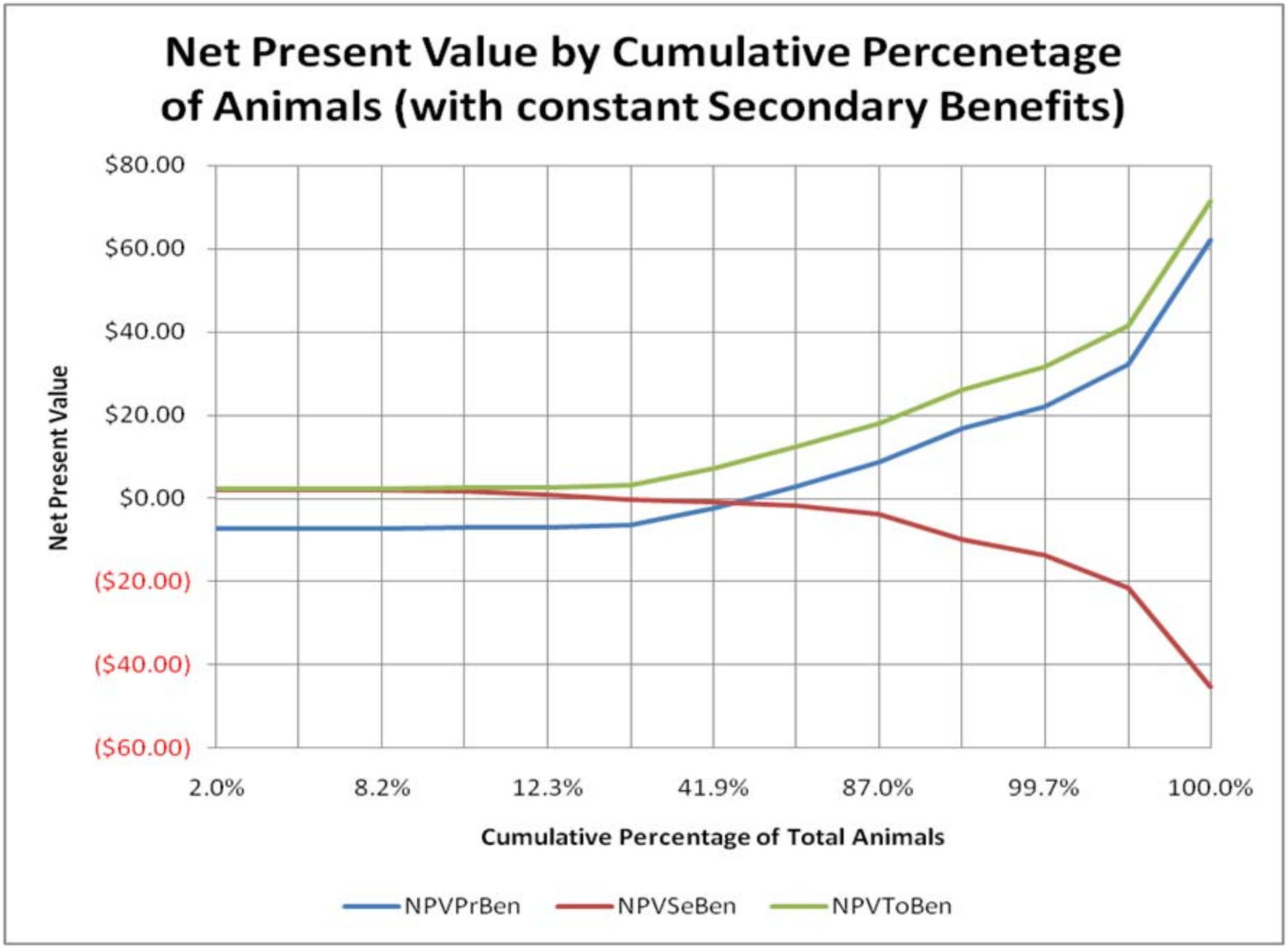

Net Present Value of Primary, Secondary and Total Benefits (with constant Secondary Benefits) by Size of Operation
$80.00
$60.00
$40.00
$20.00
$0.00
($20.00)
($40.00)
($60.00)
Net Present Value
20000
10000
1000
400
200
75
25
Size of Operation (# animals)
NPVPrBen
NPVSeBen
NPVToBen

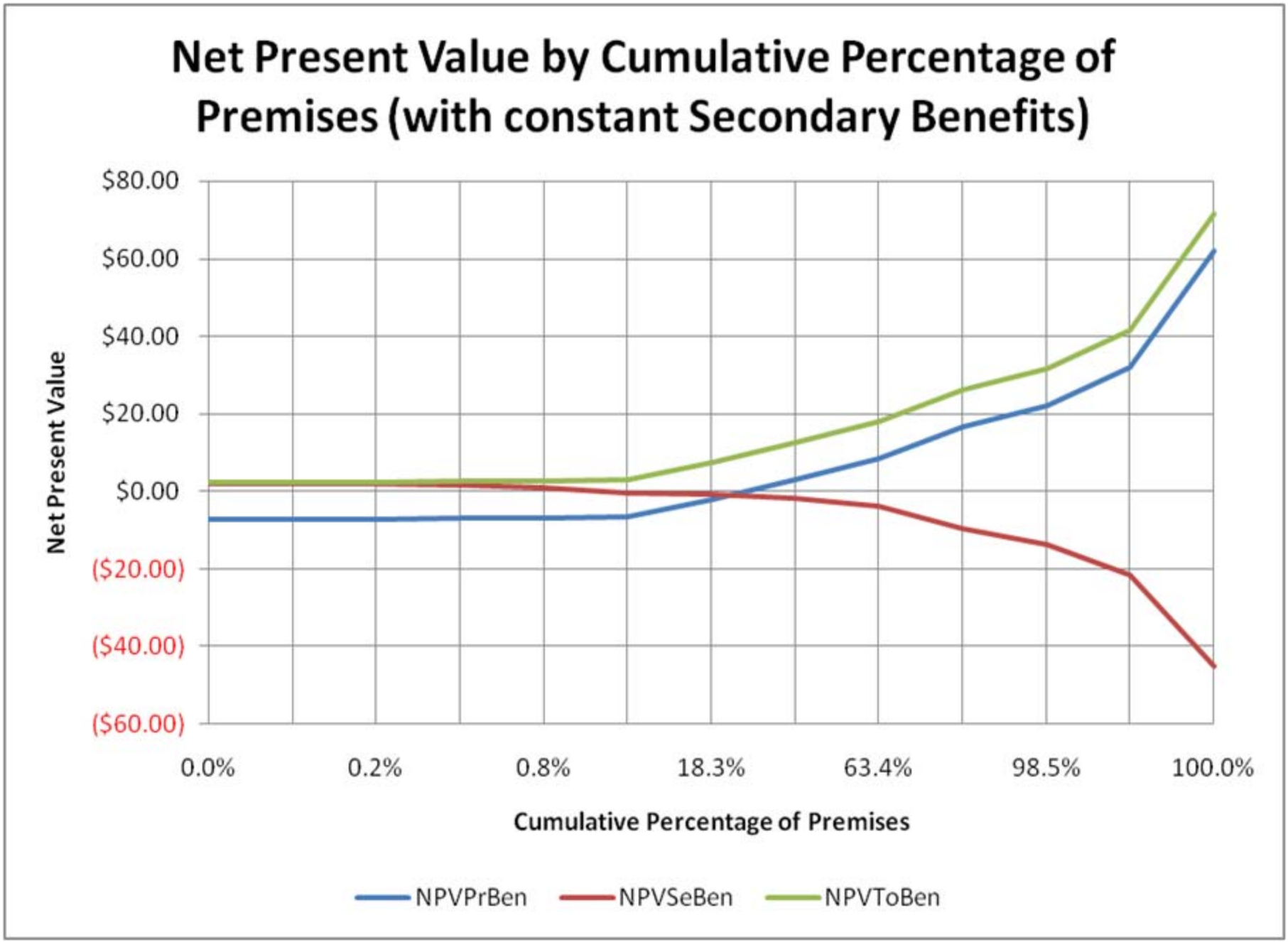
Estimating the Benefits of an Animal ID System

- In this case, the NPV of the **secondary** benefits are positive for all operations above about 400 animals, after which they become negative
- But, **primary** benefits are negative for all operations above about 400 animals, after which they become positive.
- Thus, the only incentives to adopt an animal ID system for operations below 400 animals are incentives associated with primary benefits.
- This of course assumes that ALL operations above the critical mass point adopt animal ID.

Estimating the Benefits of an Animal ID System

- Given the size distribution we have assumed, operations with more than 400 animals represent about 45% of the total animals in the industry and about 20% of the total premises.


Net Present Value by Cumulative Percenetage of Animals (with constant Secondary Benefits)
$80.00
$60.00
$40.00
$20.00
$0.00
($20.00)
($40.00)
($60.00)
Net Present Value
2.0%
8.2%
12.3%
41.9%
87.0%
99.7%
100.0%
Cumulative Percentage of Total Animals
NPVPrBen
NPVSeBen
NPVToBen

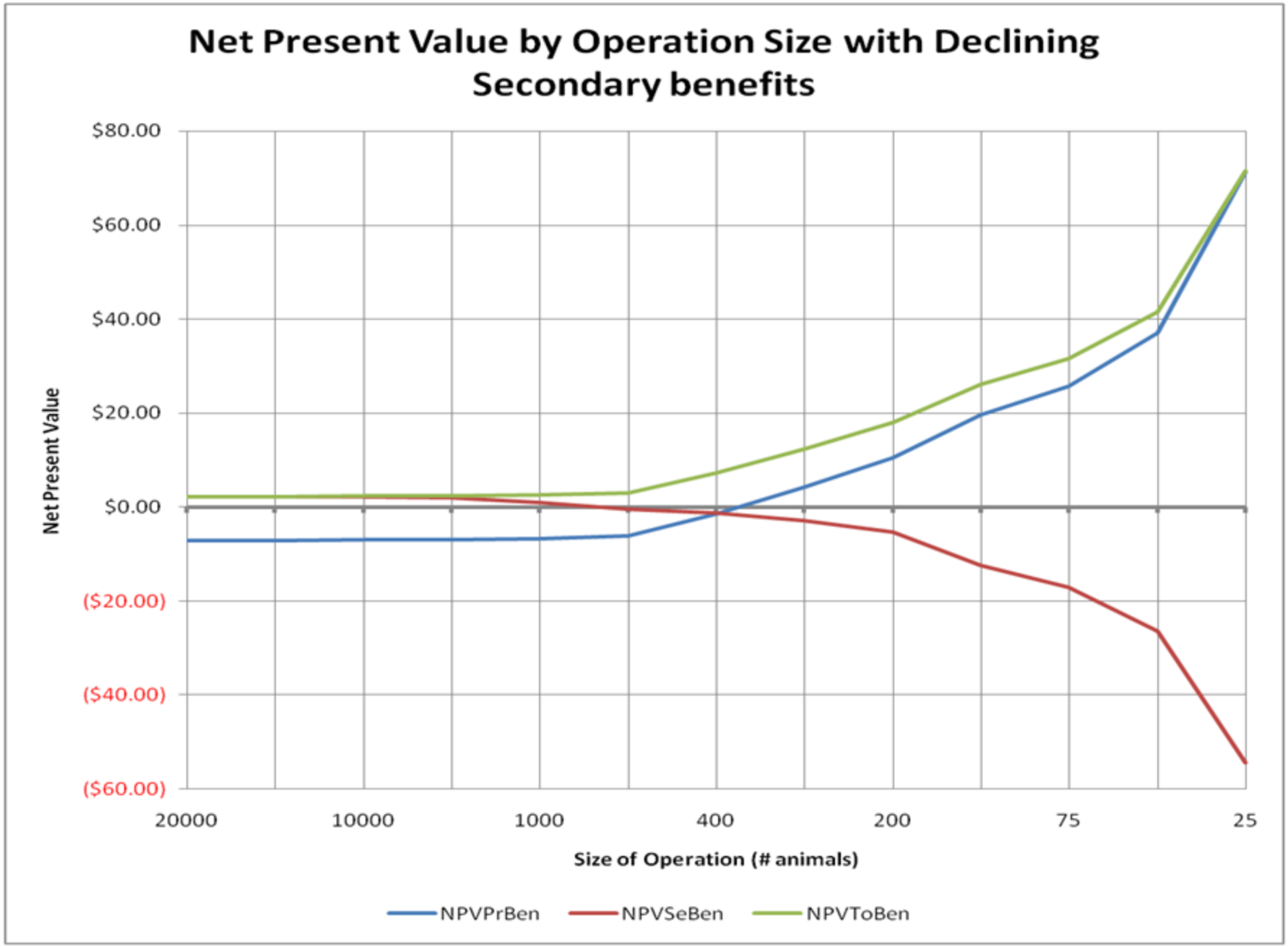

Net Present Value by Cumulative Percentage of Premises (with constant Secondary Benefits)
$80.00
$60.00
$40.00
$20.00
$0.00
($20.00)
($40.00)
($60.00)
Net Present Value
0.0%
0.2%
0.8%
18.3%
63.4%
98.5%
100.0%
Cumulative Percentage of Premises
NPVPrBen
NPVSeBen
NPVToBen

Estimating the Benefits of an Animal ID System

- It is unlikely, however, that secondary benefits will increase as the system grows.
- In fact, it is most likely that secondary benefits will actually decrease as the system grows.
- Why? Because all the secondary benefits that initial adopters gain from early adoption become so commonplace that they turn into costs of not adopting, as with almost all technologies.

Estimating the Benefits of an Animal ID System

- So, let's assume that secondary benefits actually decline as the system grows.
- We assume that secondary benefits decline as a function of n(n-1) (based on Varian (1998) and the generalized mathematics of network effects)

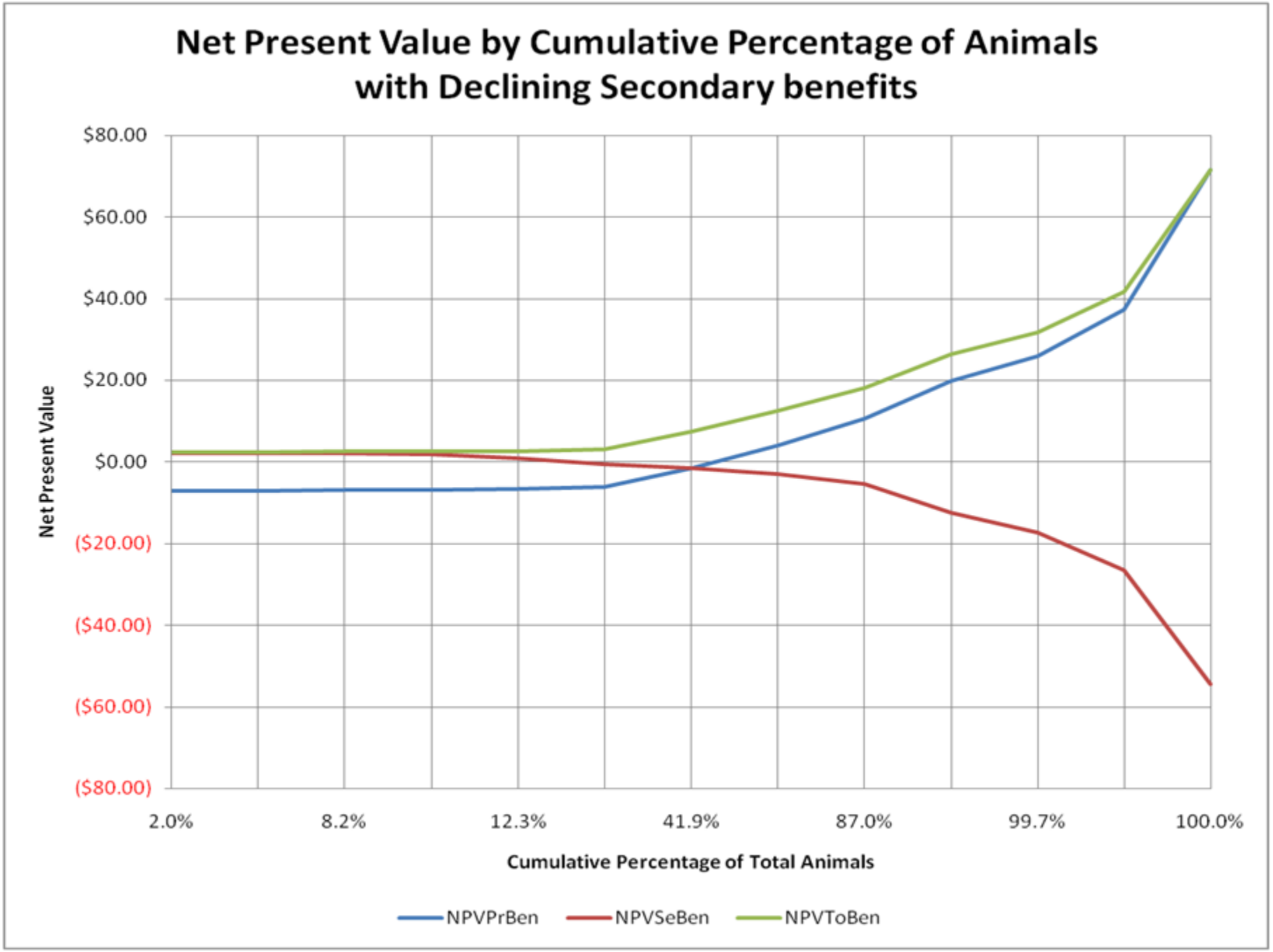

Net Present Value by Operation Size with Declining Secondary benefits
$80.00
$60.00
$40.00
$20.00
$0.00
($20.00)
($40.00)
($60.00)
Net Present Value
20000
10000
1000
400
200
75
25
Size of Operation (# animals)
NPVPrBen
NPVSeBen
NPVToBen

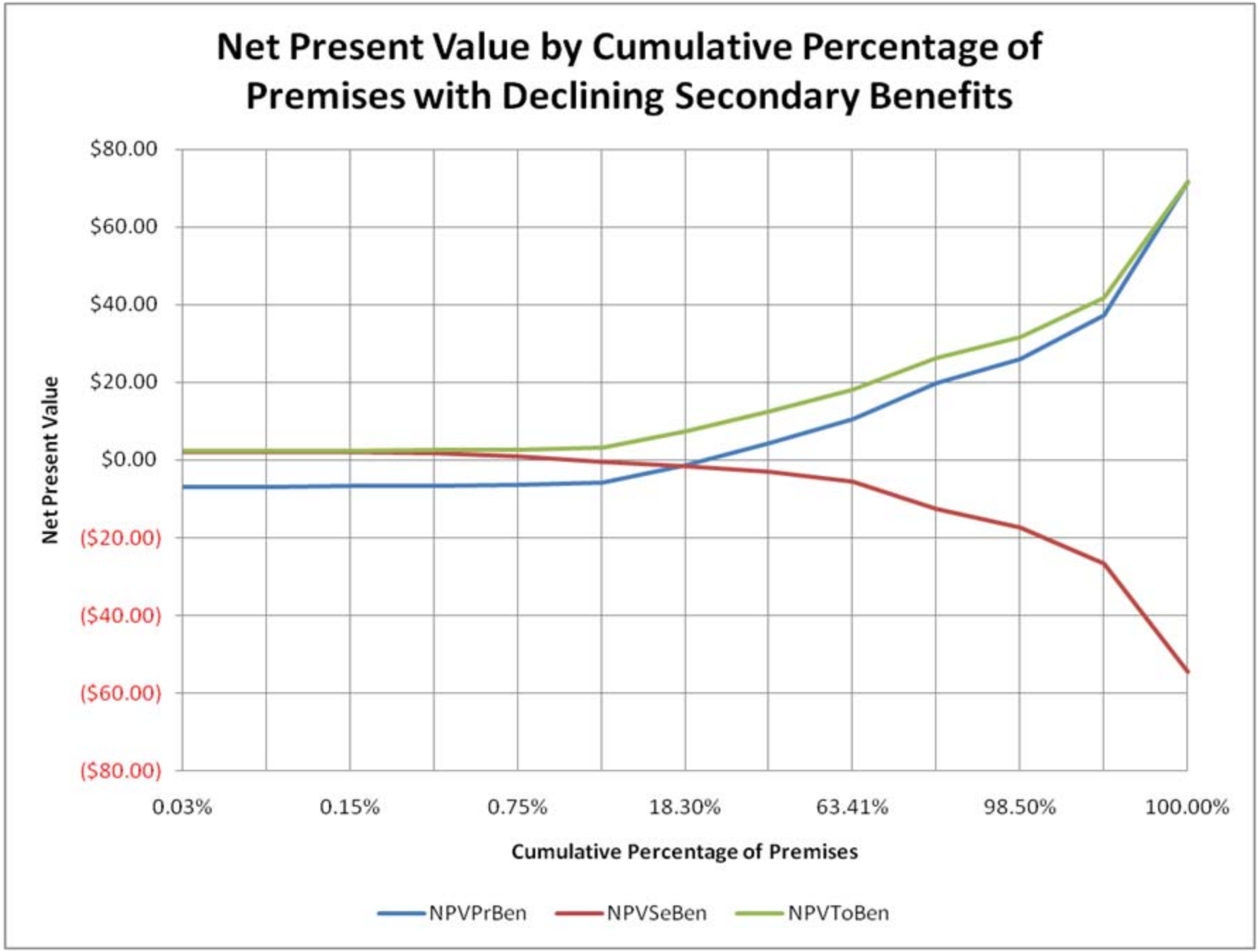
Estimating the Benefits of an Animal ID System

- With declining secondary benefits, we can now see that the NPV of secondary benefits actually becomes negative for operations below about 600 animals
- And primary benefits do not become positive until all operations above about 375 animals have adopted animal ID systems.
- That leaves a significant gap in the feasibility of adopting animal ID systems for operations below 600 animals.

Estimating the Benefits of an Animal ID System

- That gap represents somewhere between 18% - 50% of the cumulative animal distribution, and about 4% - 30% of the cumulative premises distribution.
- More importantly, it represents an area in which the feasibility of adopting an animal ID system breaks down for this industry.

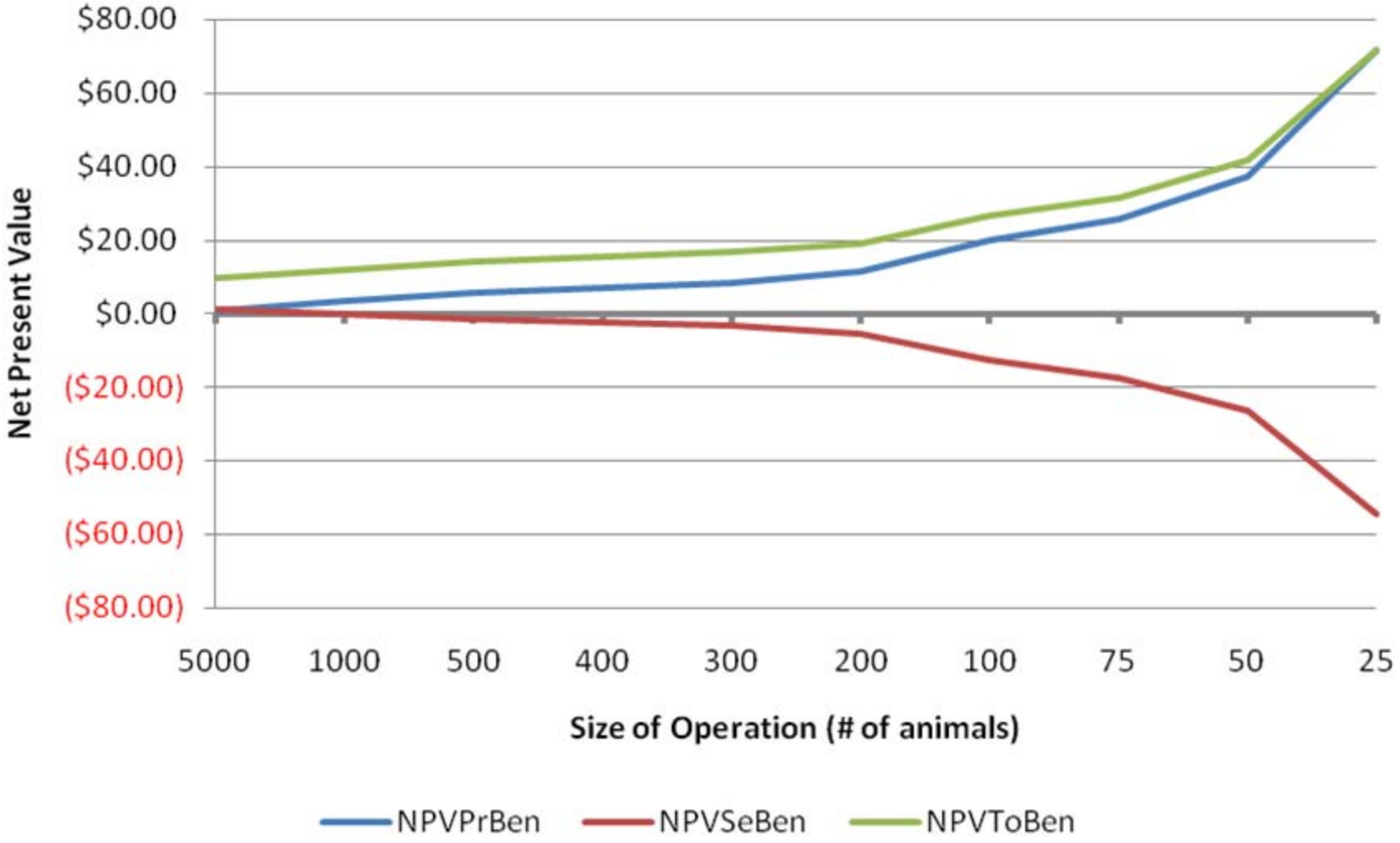

Net Present Value by Cumulative Percentage of Animals with Declining Secondary benefits
$80.00
$60.00
$40.00
$20.00
$0.00
($20.00)
($40.00)
($60.00)
($80.00)
Net Present Value
2.0%
8.2%
12.3%
41.9%
87.0%
99.7%
100.0%
Cumulative Percentage of Total Animals
NPVPrBen
NPVSeBen
NPVToBen


Net Present Value by Cumulative Percentage of Premises with Declining Secondary Benefits
$80.00
$60.00
$40.00
$20.00
$0.00
($20.00)
($40.00)
($60.00)
($80.00)
Net Present Value
0.03%
0.15%
0.75%
18.30%
63.41%
98.50%
100.00%
Cumulative Percentage of Premises
NPVPrBen
NPVSeBen
NPVToBen

Estimating the Benefits of an Animal ID System

- These results for the California beef industry are due solely to the distribution of animals and premises.
- The California dairy industry, for example, has a much more “normal” distribution of animals and premises.
- Thus, these “gaps” in feasibility do not occur for all industries.

California Dairy Industry: Net Present Value by Operation Size with Declining Secondary Benefits



Other Considerations

- There is lots more to do with this type of analysis.
- Analyzing actual distributions of animals and premises rather than the stylized ones used here.
- As mentioned previously, there are a number of cost reduction strategies that smaller producers can adopt that would reduce the costs of adoption.
- BUT, these cost reduction strategies also limit producers ability to utilize secondary benefits.
- Will dramatically reduced costs result in feasible adoption or not?
- How important is the difference between “feasibility” and “incentive” to adopt?

Conclusions

- Voluntary systems only work up to a point – after which it will be necessary to make it mandatory.
- There are good arguments for NOT making it mandatory from the very start
  - Industry buy-in
  - Political buy-in
  - Mandatory programs have a nasty habit of not being a socially optimal outcome.

Conclusions

- There are a number of ways of overcoming the free-rider problems without making the system mandatory:
  - Industry Induced Market Standards
  - Subsidies
  - Taxes
  - Changing Property Rights
  - Indirect Legislative actions