Economic Analysis of Breeding Programs in Competitive Markets

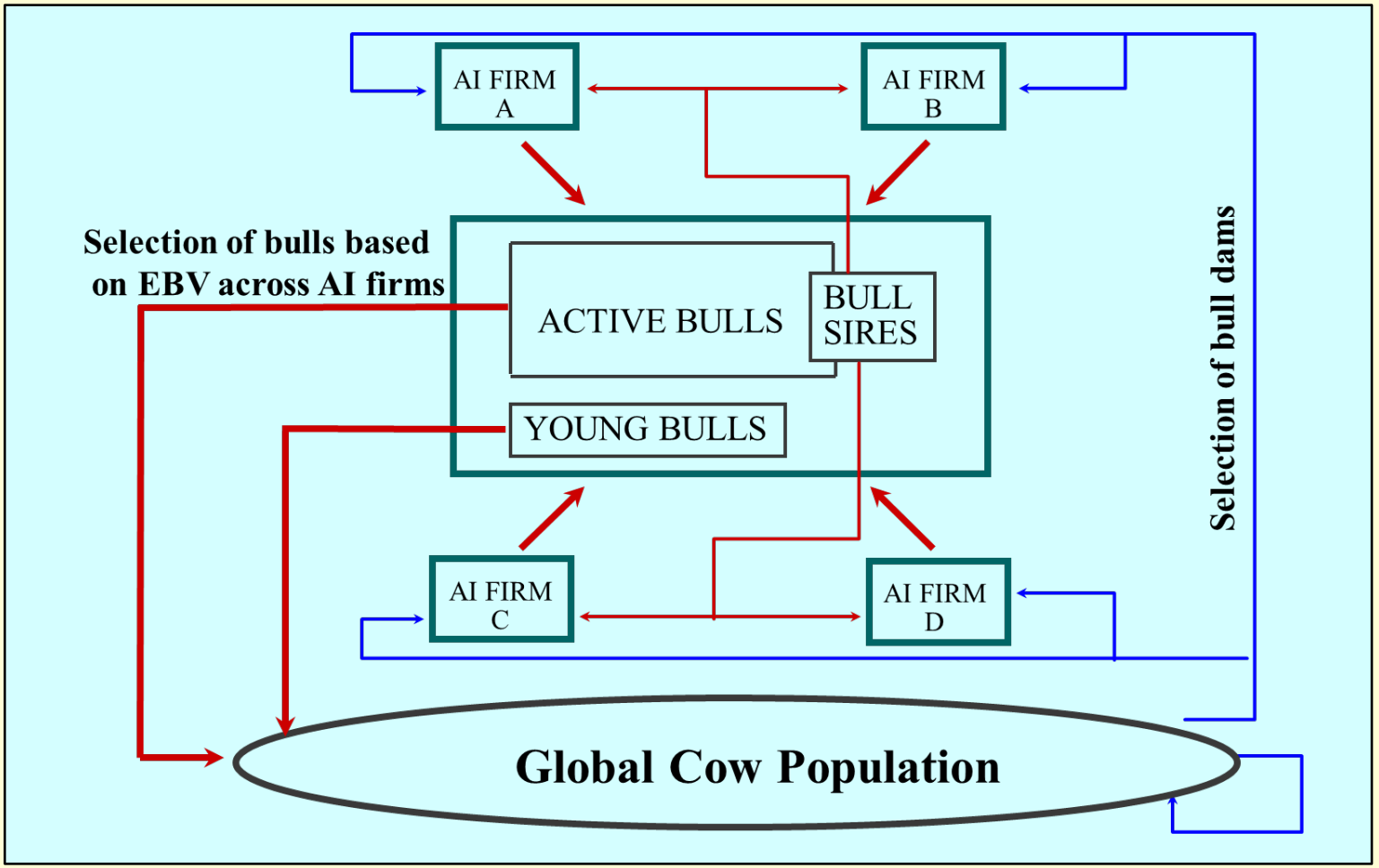
Impact on Market Share

Jack Dekkers

Evaluating returns from breeding programs:

1. Based on extra profit at the commercial production level – based on GeneFlow methods
2. Based on evaluating impact on market share and sale of breeding stock
   - More relevant for programs that operate in a competitive marker environment

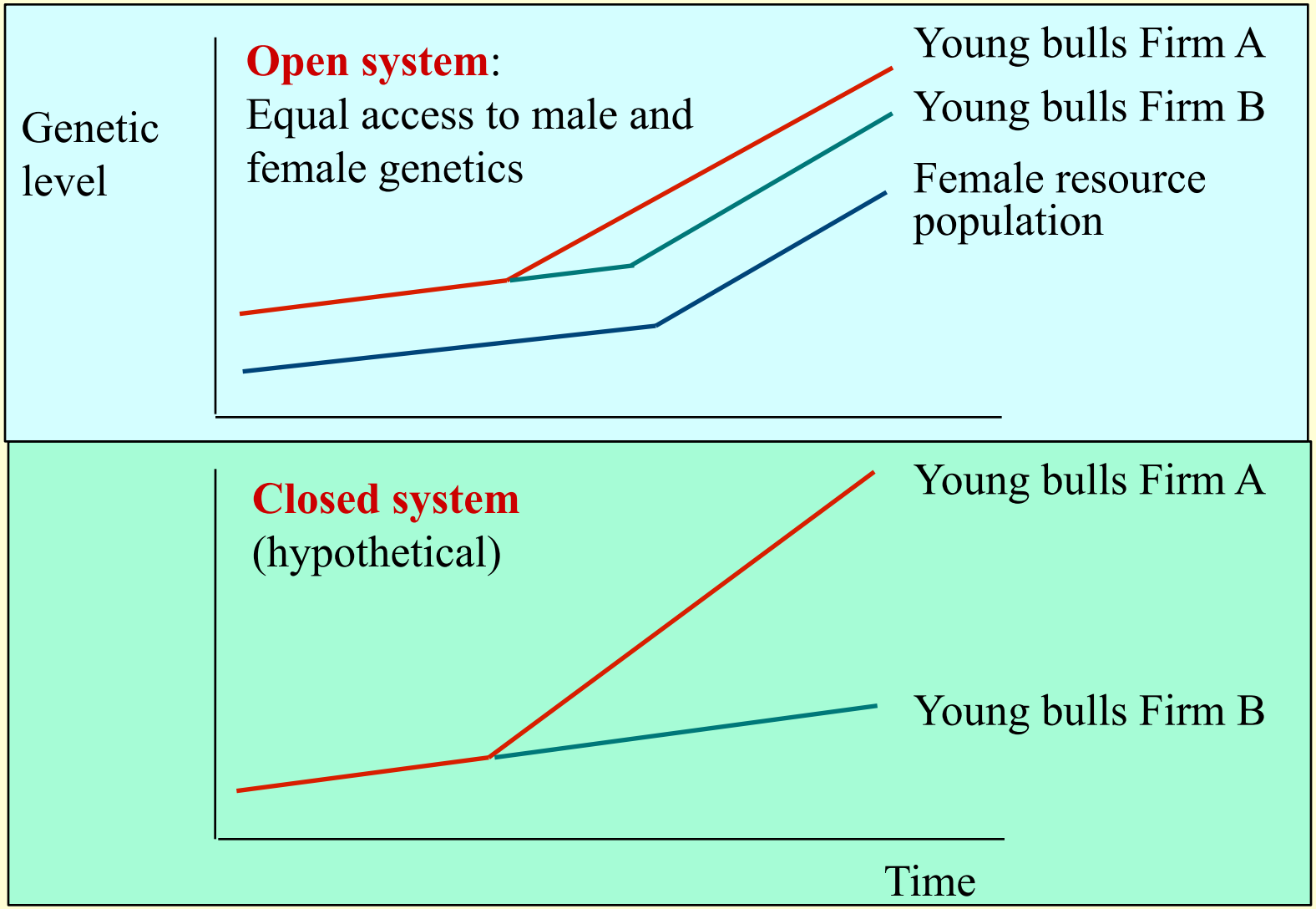
A Competitive Global Dairy AI Industry



- global competition for germplasm from progeny-tested bulls
- competition for contracting bull dams
- all competitors have access to semen from all progeny-tested sires for use as bull sires.

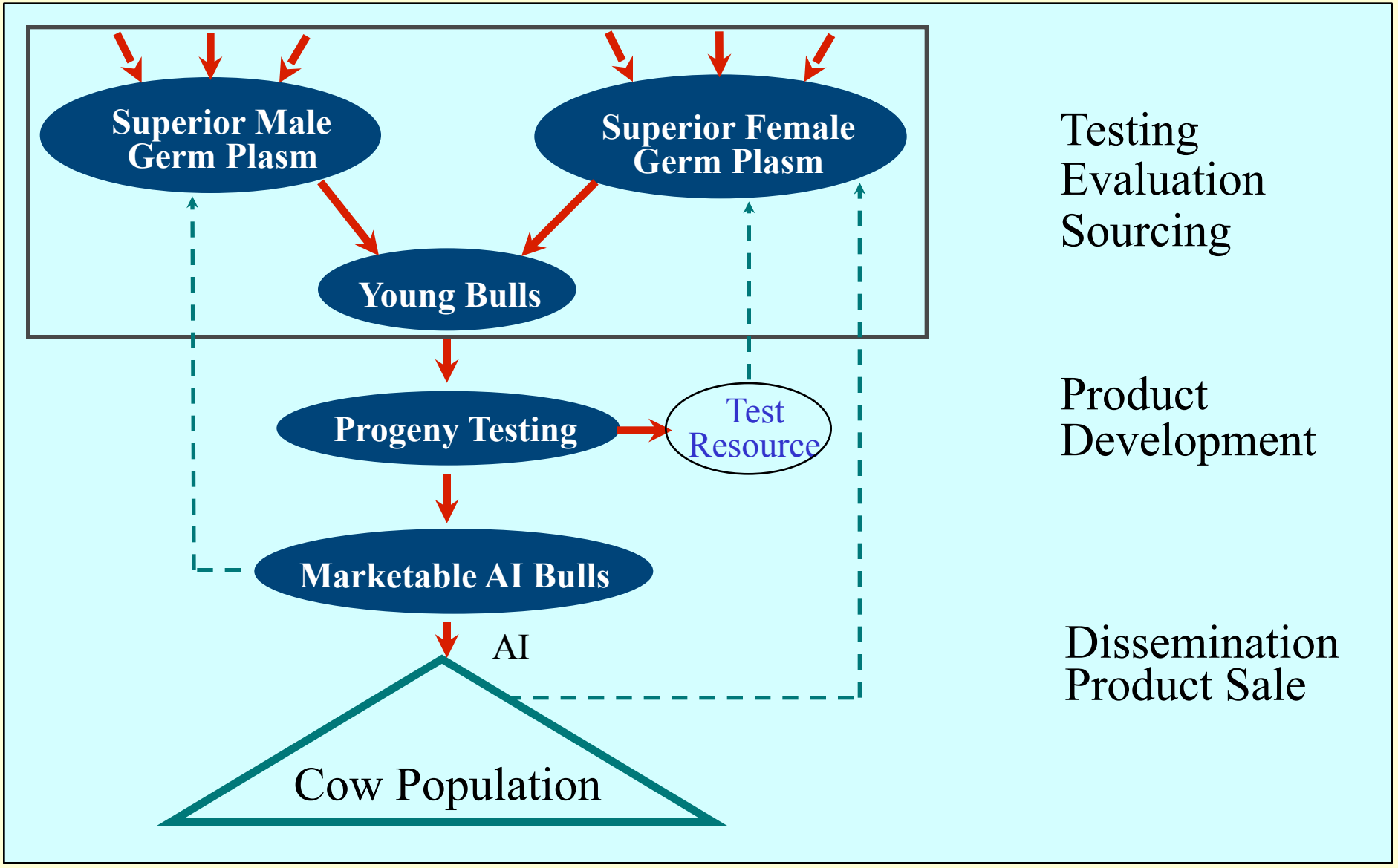
- an AI firm's program is part of a single global breeding program
- at equilibrium, all AI firms improve at the same rate but with genetic lags

Impact of Improving Rate of Response by Firm A in a Competitive Market



Based on these considerations, commercial breeding firms must look at breeding programs from a different perspective

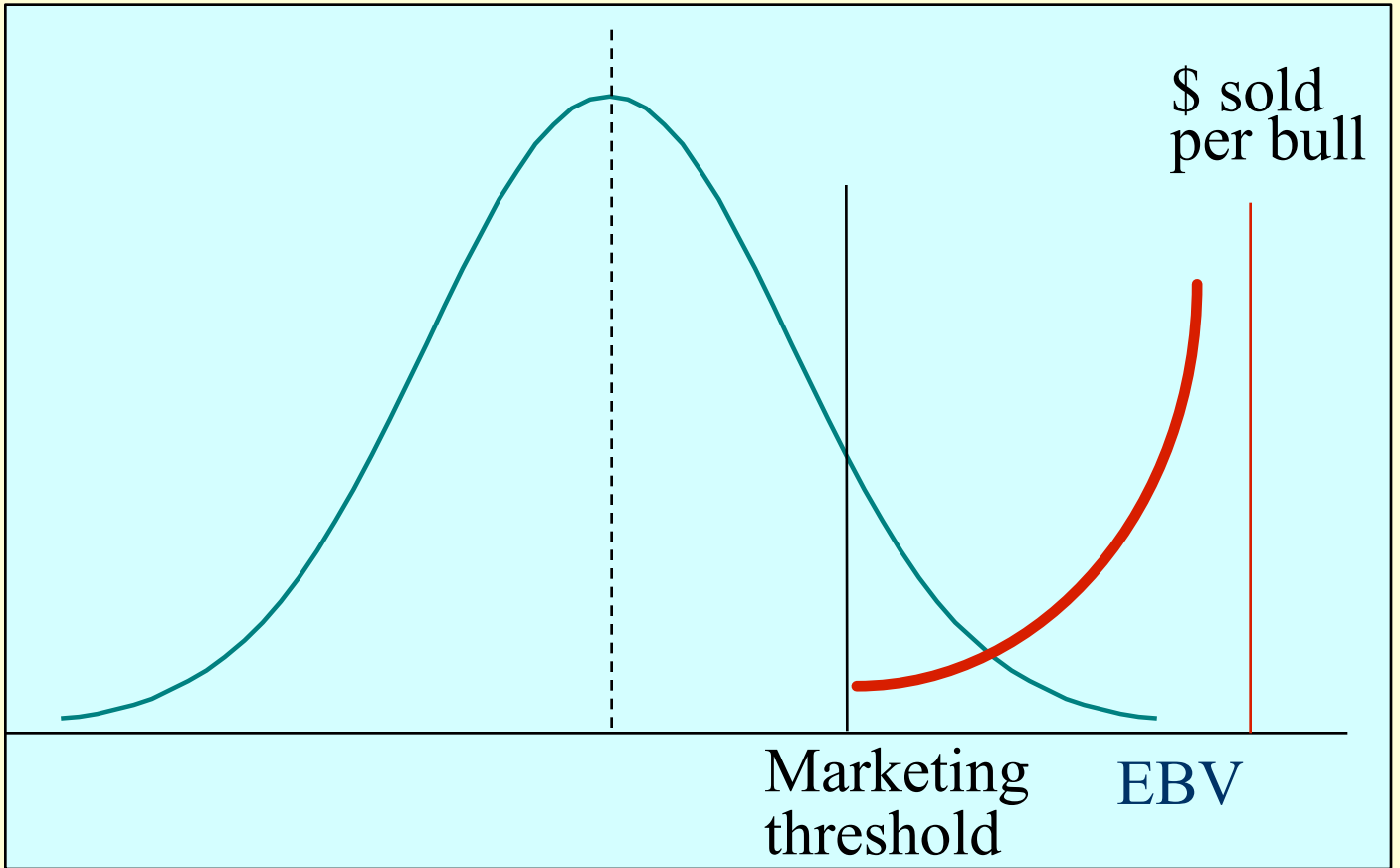
Breeding Company View of AI Progeny Testing Programs



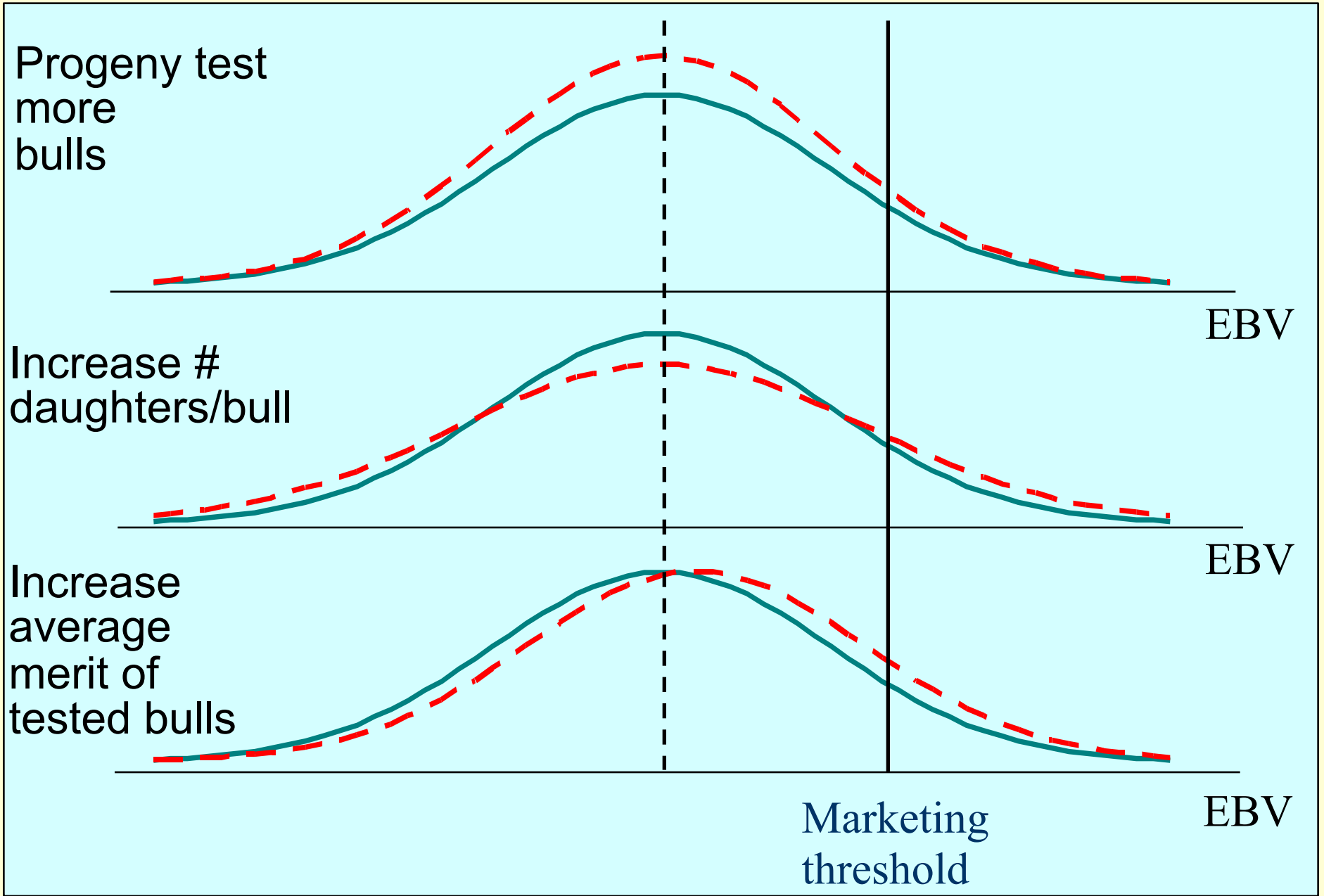
Returns generated by sale of germplasm from marketable bulls

Determined by:

- # marketable bulls
- Ranking of marketable bulls
  - → # doses sold
  - → $/dose sold



Three ways to increase Market Share



Example of Economic Optimization of Progeny Group Size in Dairy Cattle

Dekkers, VanderVoort and Burnside

1995, J. Dairy Sci. 79:2056-2070

Optimal combination of # bulls to sample
and # daughters tested per bull
for a fixed testing capacity?

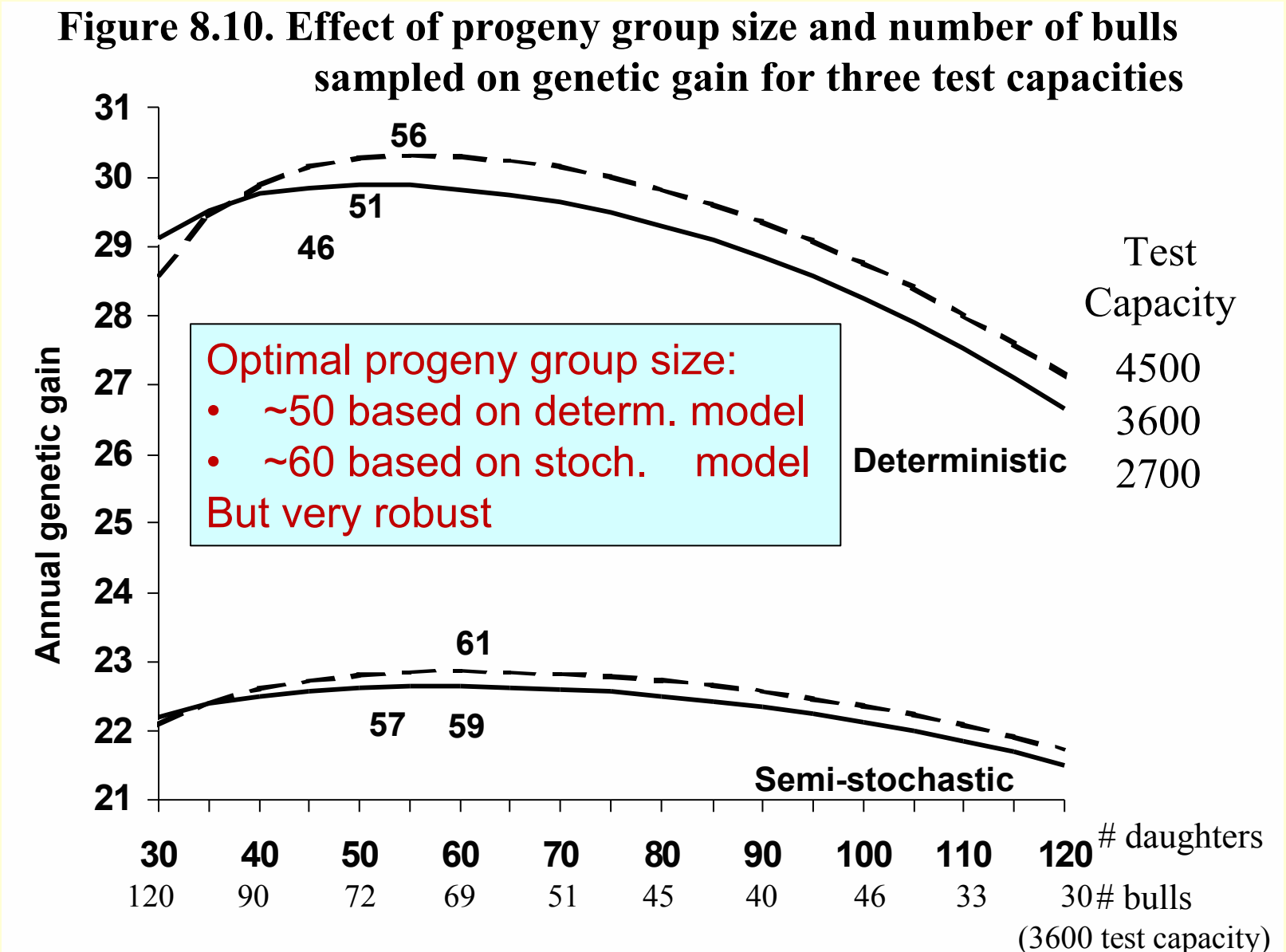
= total # young bull daughters

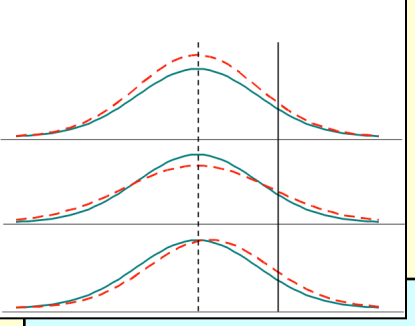
Based on Stochastic Simulation of 3 competing AI firms

Base program: each AI firm tests 60 bulls/yr
with 60 daughters/bull

Maximizing Genetic Gain in the Population

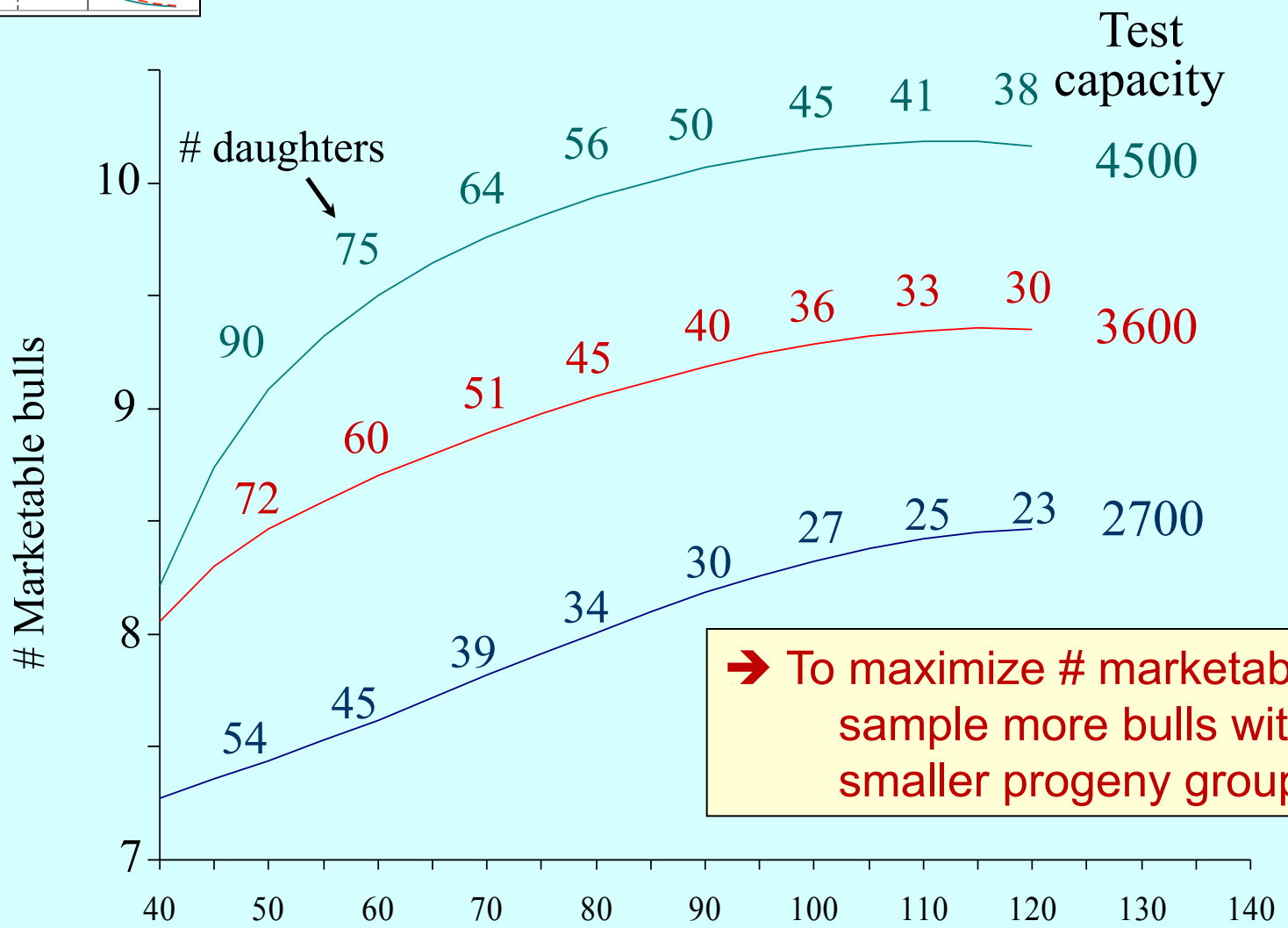
Based on collective effect of all three firms



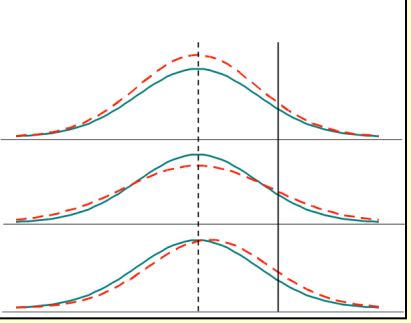


Market Share with Fixed Test Capacity

For an AI firm that changes its program while the other two firms maintain the base program (60/60)

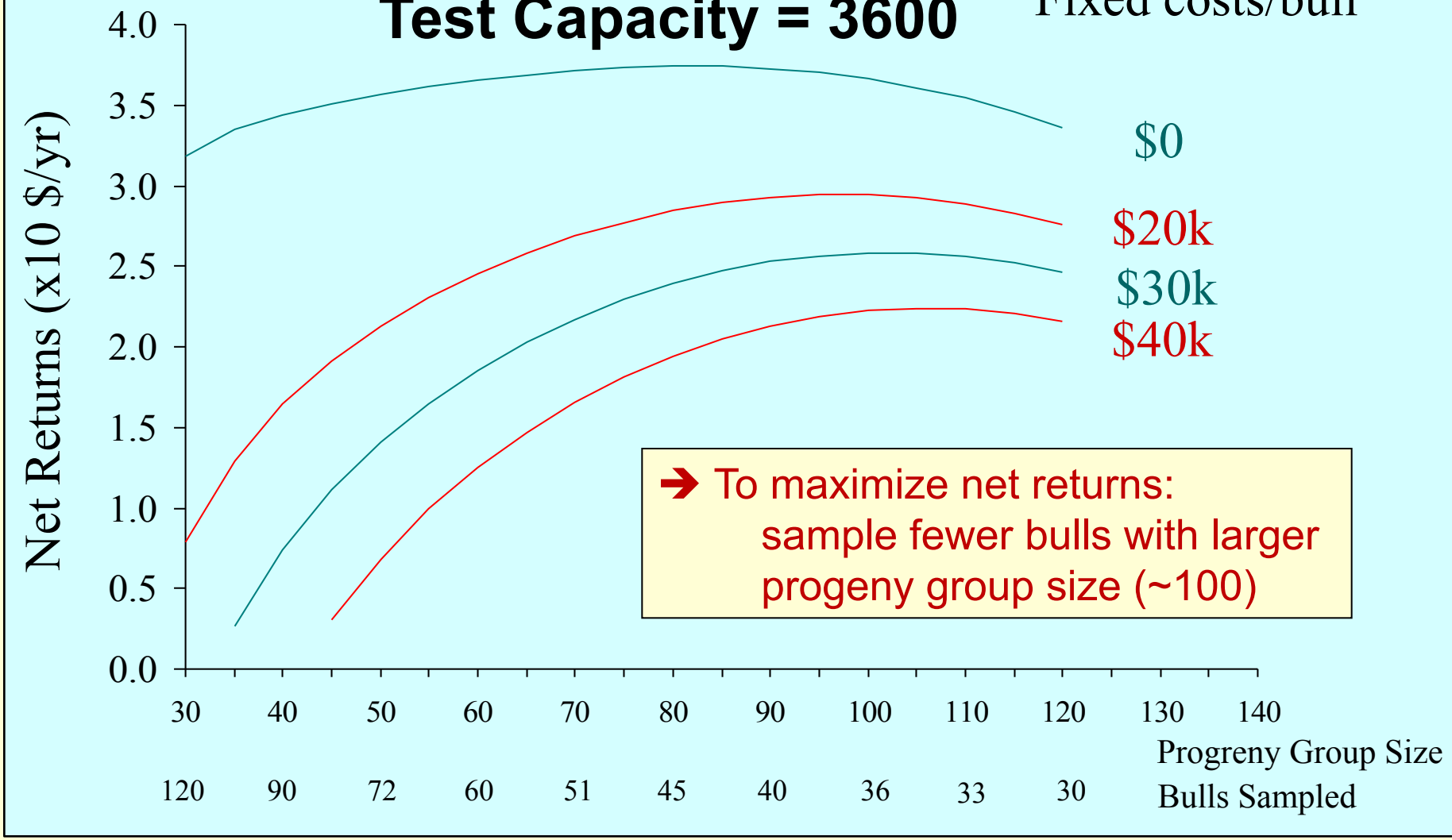


➔ To maximize # marketable bulls: sample more bulls with smaller progeny group size



Maximizing Net Returns from Semen Sales

Costs = (# bulls tested) x (Fixed costs/bull)
+ (test capacity) x (cost/daughter)



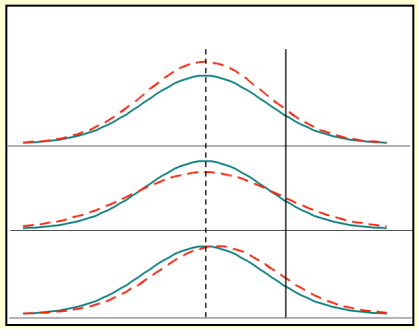
➔ To maximize net returns:
sample fewer bulls with larger progeny group size (~100)

Sensitivity Analysis of Optimal progeny group size for fixed test capacity

	Test Capacity					
	2700		3600		4500	
	Fixed costs per bull ($x10^3$)					
Deviation from base[1]	$20	$30	$20	$30	$20	$30
	---------- Optimum progeny group size ----------					
None	98	102	97	102	97	103
Linear price function	92	97	91	98	91	98
Population size +20%	96	100	95	100	95	100
Population size -20%	100	104	100	105	100	107
Semen price +20%	97	100	95	100	95	100
Semen price -20%	100	104	100	105	100	107
Interest 8%	100	104	99	104	100	106
One competitor at 100 dt/bull	99	102	99	103	99	105
	--Extra profit ($x10^4$ $/yr) at optimum versus at 60 daughters/bull--					
None	49	66	49	73	56	86
One competitor at 100 dt/bull	54	72	56	80	61	92
Linear semen price	28	44	28	50	34	61
	----------Shadow value of test capacity ($/daughter)---------					
None	376	274	338	238	289	195
Linear semen price	397	287	352	246	305	207
Population size +20%	454	348	416	313	377	278
Population size -20%	259	161	229	134	200	109
Semen price +20%	495	389	448	344	398	300
Semen price -20%	259	161	229	134	200	109
Interest 8%	282	183	251	155	219	128
One competitor at 100 dts/bull	261	163	242	145	222	129

In the base situation population size is 950,000 cows, semen price is based on a quadratic function of estimated breeding value, average semen price is $15, interest rate is 5% per year, and the three competing AI firms sample 60 bulls with 60 daughters each.

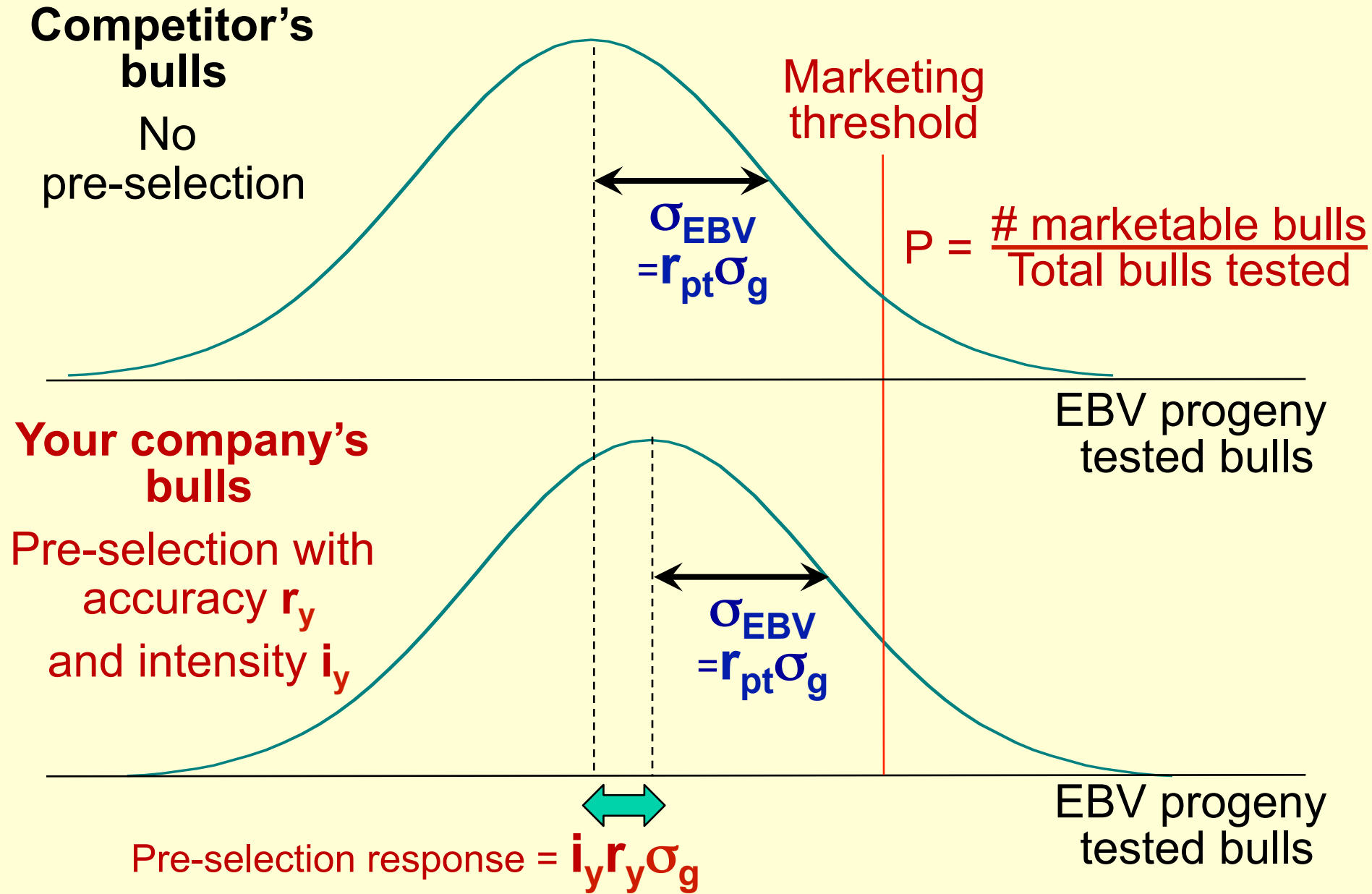
Increasing Market Share by improving Average Genetic Merit of Young Bulls entered into Progeny Testing Program



1. Increase genetic merit of bull sires and bull dams

2. Pre-selection of young bulls based on markers or GEBV

Deterministic modeling of the effect of pre-selection on market share



Deterministic modeling of the effect of pre-selection on market share

This can be modeled using Multrunc.xls or Truncsel.xls

Truncation selection across multiple distributions.

Function multrunc returns the unique truncation point (T) across N normal distributions that make up a population
to select an overall proportion P of the
population.
Each distribution has a frequency, mean and standard deviation,
which must be provided.

Data to be provided - yellow highlight:

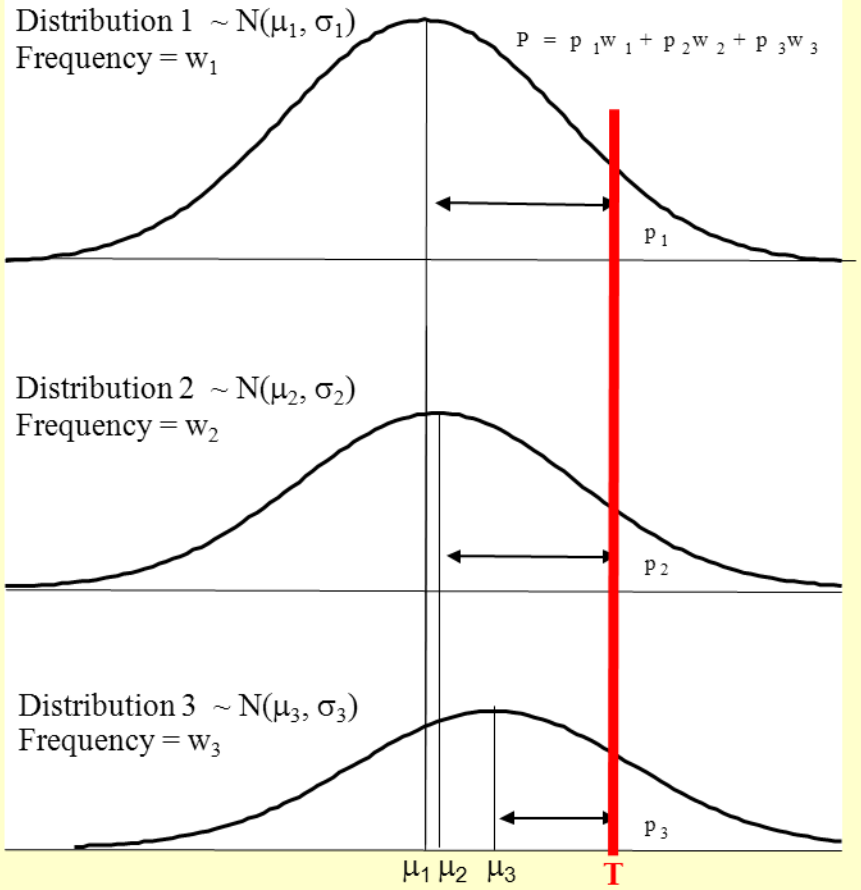
Proportion selected P =		0.3	
Distribution	Frequency	Mean	Stdev
1	**0.30**	**15**	**0.5**
2	**0.70**	**12**	**0.5**
3	**0.00**	**16**	**0.5**
4	**0.00**	**9**	**0.5**

Derived data

Fraction selected from each distribution	Cumulative proportion selected
0.998	0.299
0.001	0.300
1.000	0.300
0.000	0.300

Answer =	Unique truncation point T =	**13.565**

Truncation selection of a proportion P across multiple overlapping distributions



Exercise

Use Multrunc.xls to evaluate the impact of pre-selection of young-bulls based on GEBV on # marketable progeny-tested bulls

Assumptions:

- Selection is for total merit with $h^2 = 0.3$ and $\sigma_g = 10$
- Competitors and your company have equal access to the same groups of bull dams and bull sires.
- Competitors jointly test 200 bulls without pre-selection and 60 dtrs/bull
- Your company tests 100 bulls with pre-selection and 60 dtrs/bull
  - Pre-selection is based on selecting the best 100 out of 200 calves based on a GEBV with accuracy = 0.4
- The top 30 bulls based on their progeny test EBV (based on 60 daughters only) are marketable
  - GEBV or pedigree do not contribute to progeny test EBV

Economic Appraisal of the Utilization of Genetic Markers in Dairy Cattle Breeding

E. W. BRASCAMP, J.A.M. van ARENDONK, and A. F. GROEN
Department of Animal Breeding
Wageningen Agricultural University
PO Box 338
6700 AH Wageningen, The Netherlands

Financial returns, $ per cow	7.0	14.0	21.0	20.1	40.2	60.3

[1]Financial returns were calculated using Equation [2]. GR* = ΔG (DF/DR) where GR is the discounted financial returns, ΔG is the annual genetic improvement, DF/DR is the approximated discounted expression, and 1/DR is the discounted expression per cow if genetic improvement is expressed immediately in yr 1 after selection and pertained to infinity. The following parameters were used: σ_A = $67, DF/R was 7 for progeny-testing and 10 for open nucleus %) for the breeding schemes.

onal semen

sales ($1000) at a discount rate of 0 and .05 for two reactions of competitors (A and B).[1]

Alternative	Effect of preselection (σ_A)	Fraction of young bulls selected	Share in proven bulls used	Cumulative extra semen sales[2] r = 0	Cumulative extra semen sales[2] r = .05
Base	0	.1000	.2500	0	0
A	.15	.1229	.3073	10,314	5032
A	.30	.1476	.3690	21,419	10,450
A	.45	.1737	.4343	33,173	16,184
B	.15	.1229	.3073	516	385

[1]In alternative A, the changing firm changes to markers to continue selection for 25 yr, and the competitors do not react. In alternative B, the competitors use markers from

[2]The extra semen sales have been computed for a total o
The returns from one successful AI are $12.

affects the semen sales during 1 yr. For an AI firm with 250,000 cows and an effect of preselection of .15σ_A, the expected returns using the first approach were $1,750,000, but greater discounted returns from extra semen sales were only $281,000. The results for the