A Principal-Agent Theory of Courtship Feeding, Nuptial Gifts and Divorce

Joan Roughgarden

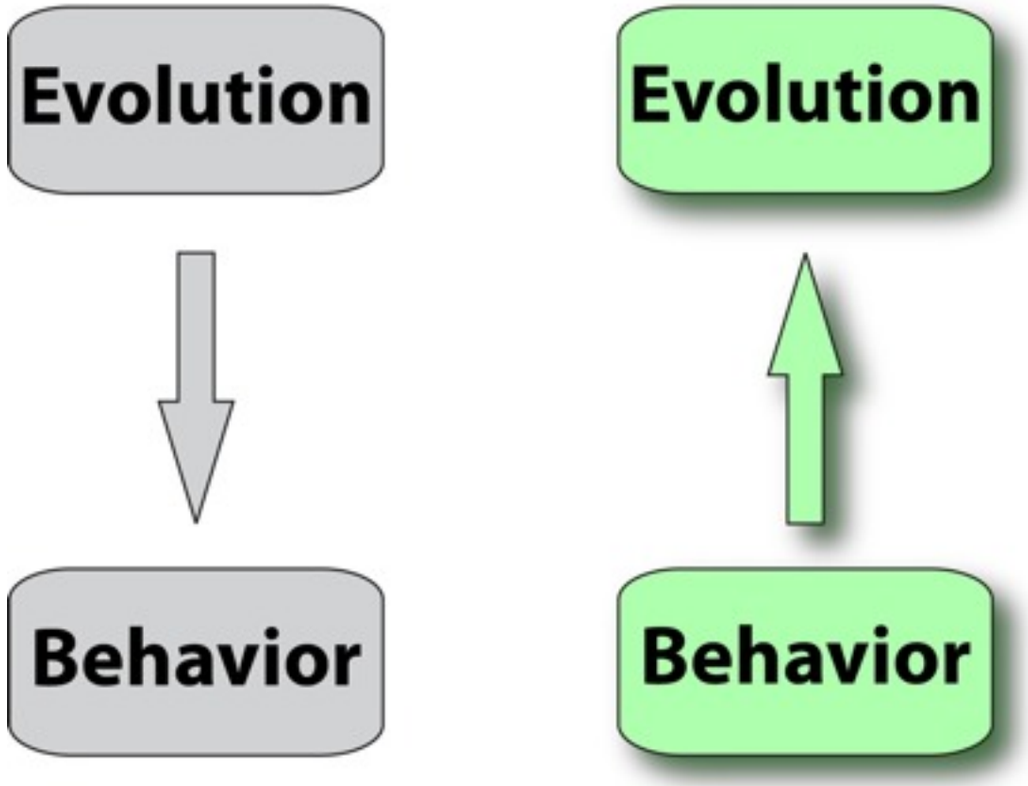
Adjunct Professor, Hawai`i Institute of Marine Biology, U. of Hawai`i
Professor Emerita, Dept. of Biology, Stanford University

for

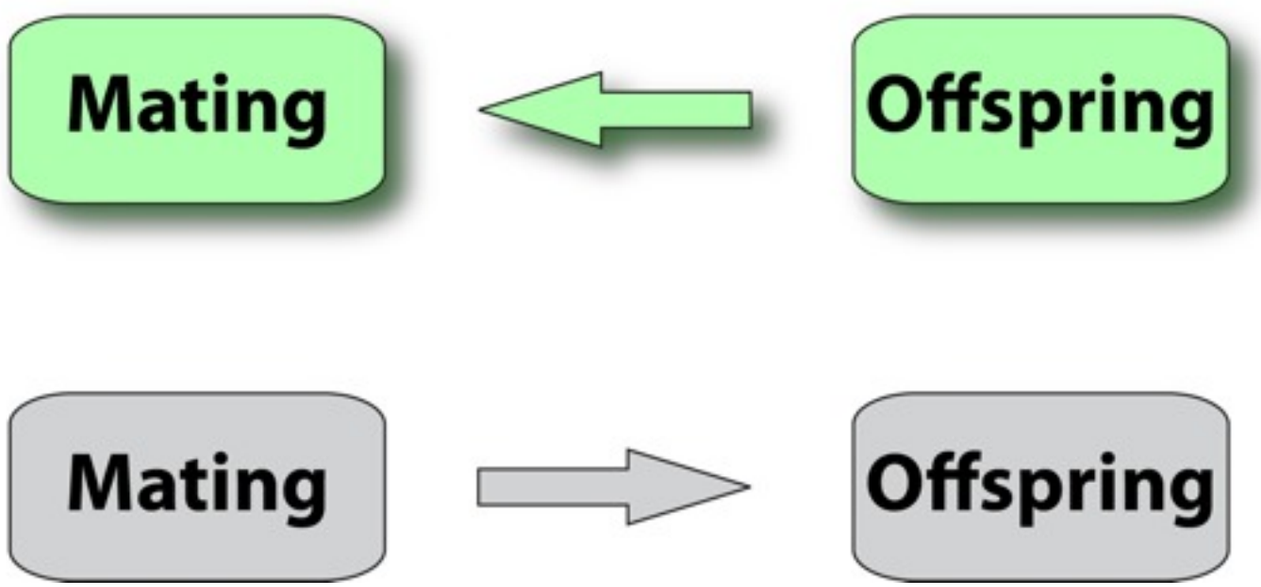
Kavli Institute of Theoretical Physics, UC Santa Barbara
February 4, 2013

Nicole Bouglouan
Jardin
10/04/05

Top-Down *vs.* Bottom-Up



Forward-Induction *vs.* Backward Induction



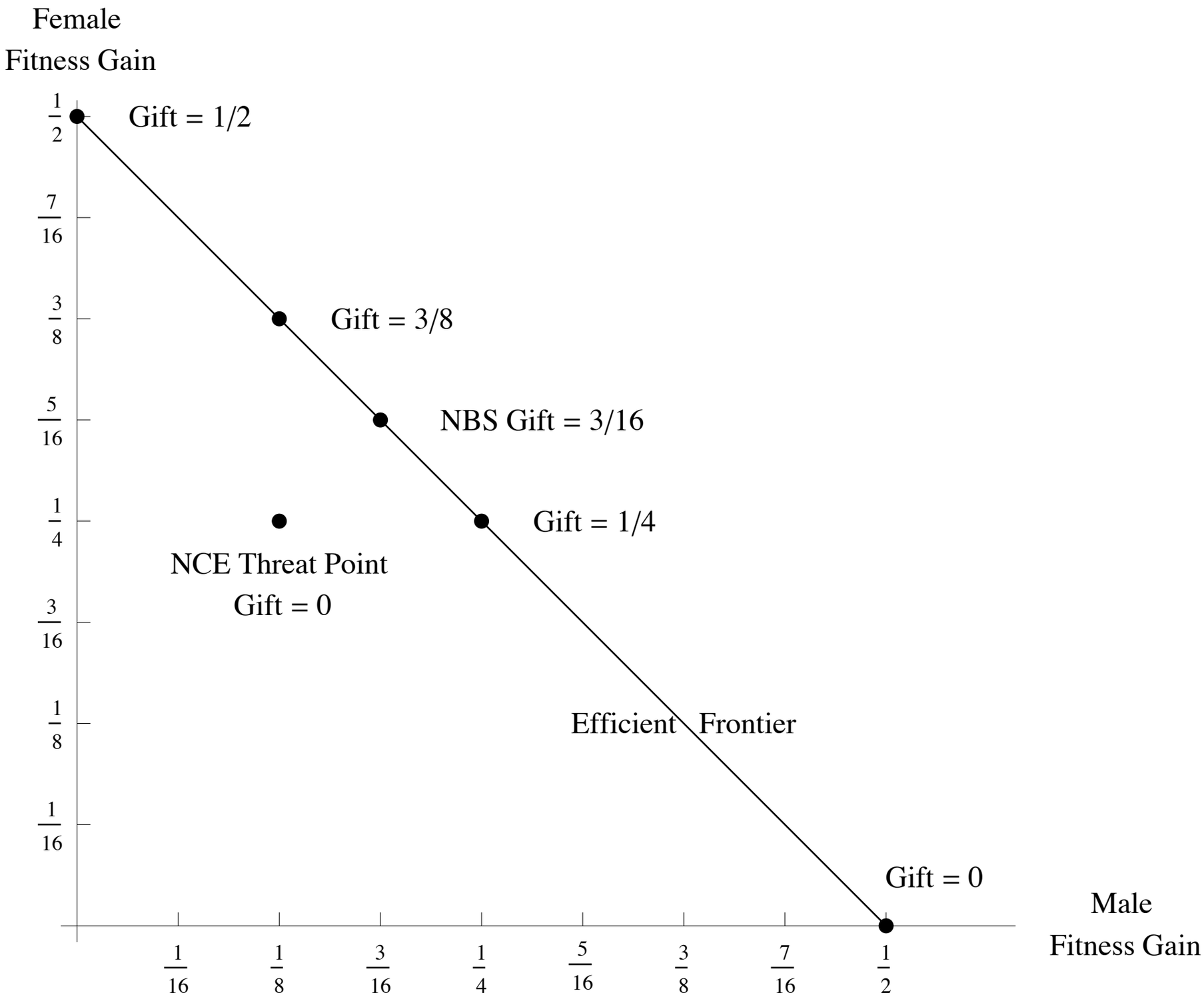
Principal-Agent Model: Nuptial Gifts and Courtship Feeding

$$W_f = N + C - MC + W_{fo}$$

$$W_m = sMC - fC^2 - gN \geq W_{mo}$$

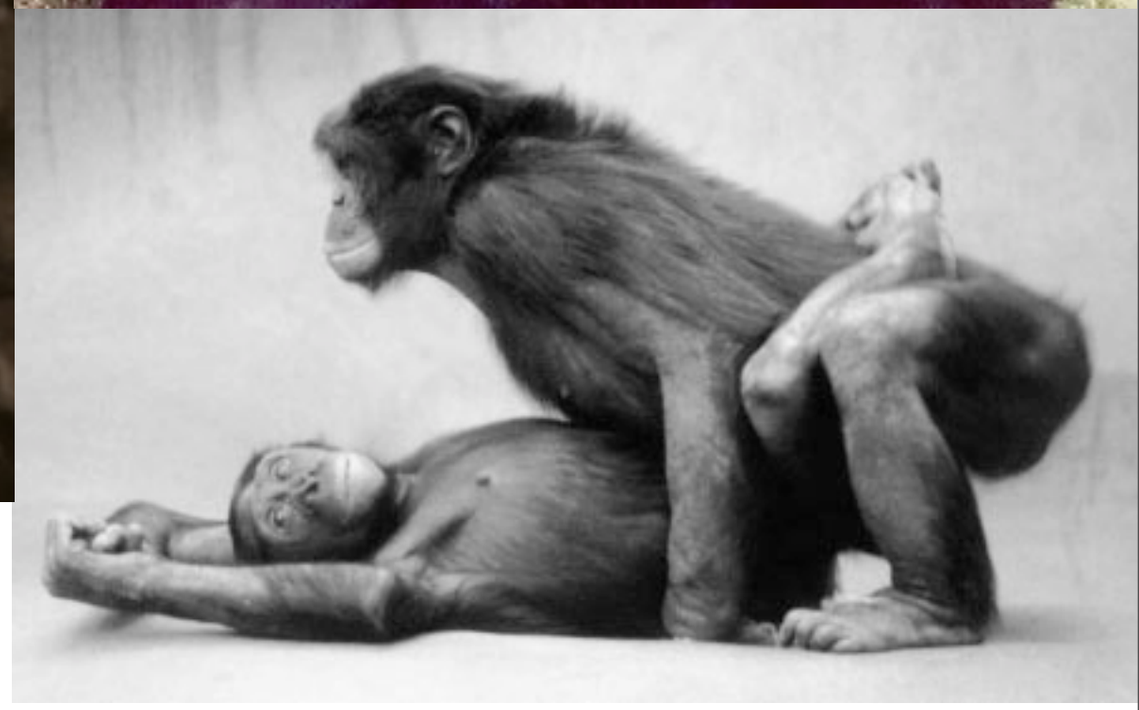
W_f	Female Fitness Increment
N	Nuptial Gift
C	Courtship Feeding
MC	Payment Expended for Feeding
W_{fo}	Female Outside Option
W_m	Male Fitness Increment
sMC	Payment Received for Feeding
fC^2	Foraging Cost of Courtship Food
gN	Cost of Nuptial Gift
W_{mo}	Male Outside Option

Principal−Agent Courtship
Without Outside Options

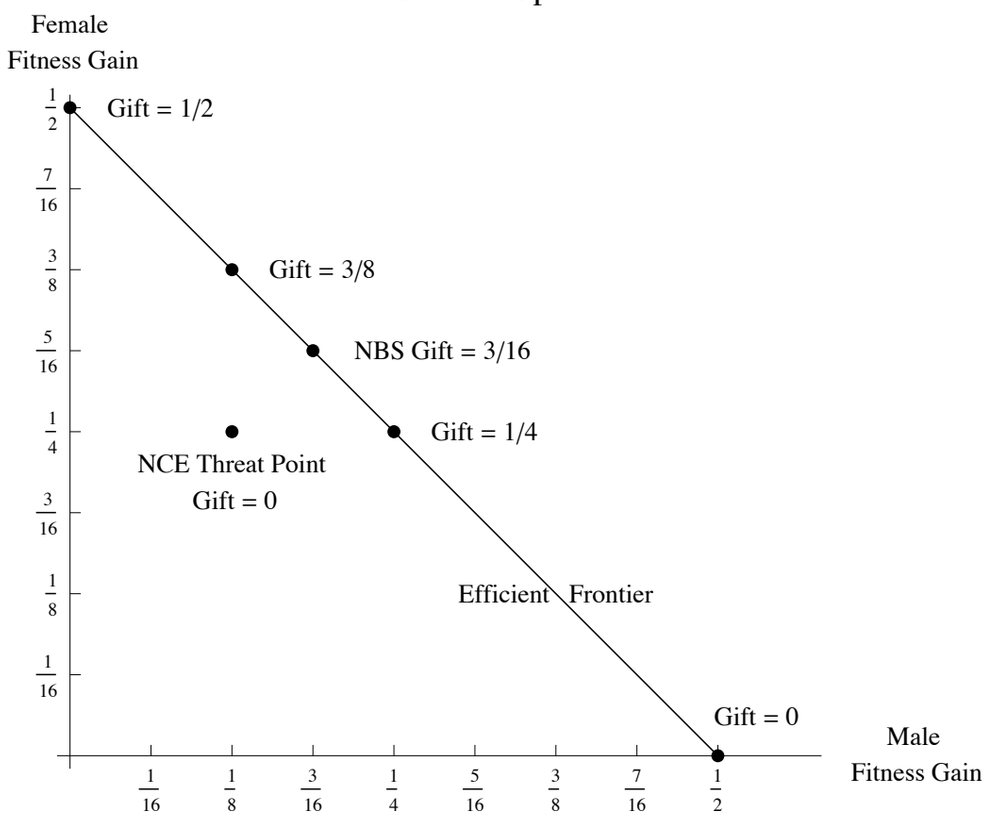


$$s \to 1,\ f \to 1/2,\ g \to 1,\ W_{fo} \to 0,\ W_{mo} \to 0$$

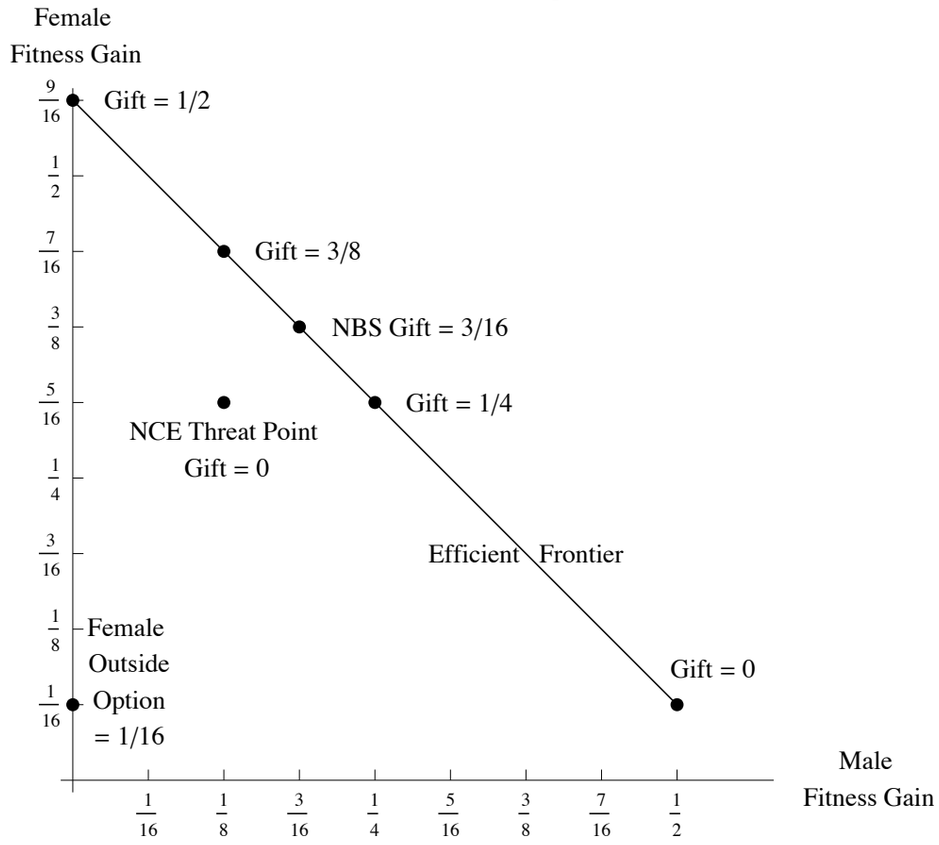
Teams



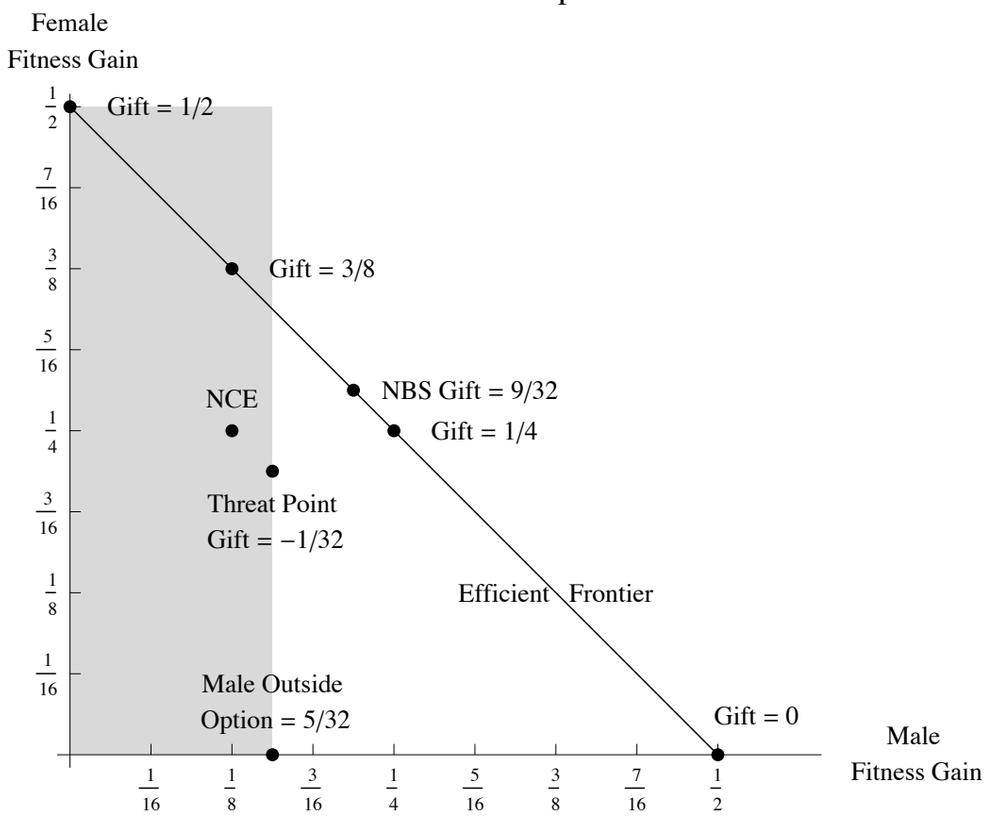
Principal–Agent Courtship
Without Outside Options



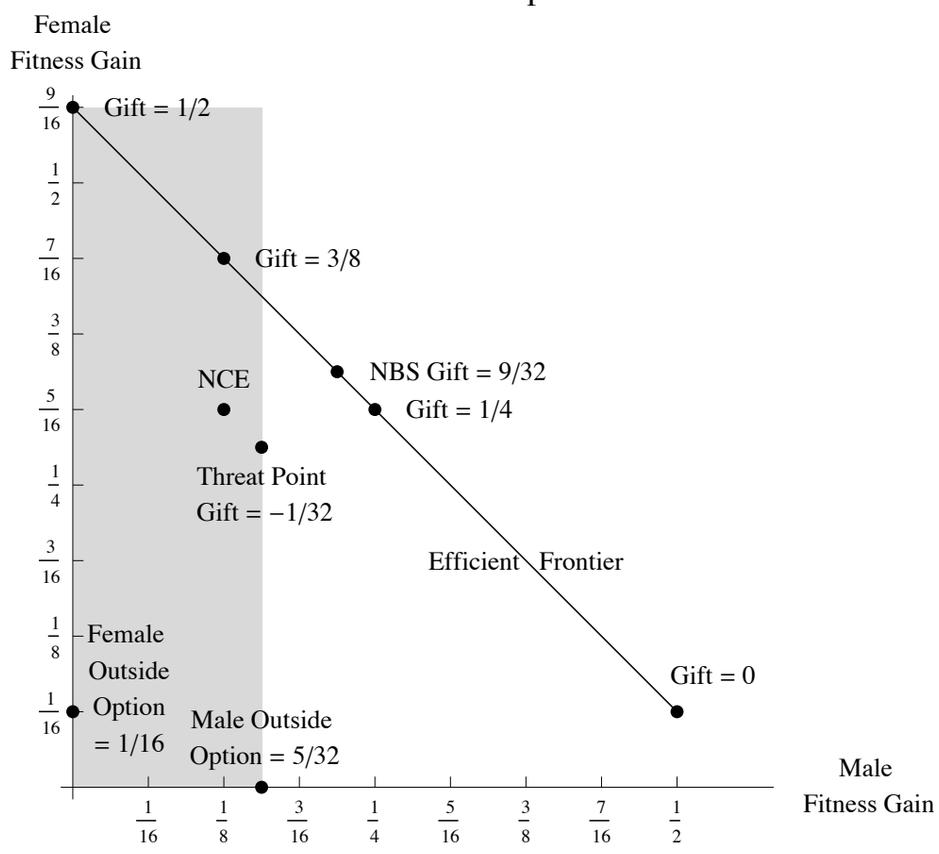
Principal–Agent Courtship
Female With Outside Option



Principal–Agent Courtship
Male With Outside Option



Principal–Agent Courtship
Both With Outside Options



Condition for Continued Pairing

$$T_f = N + C + W_{fo} \qquad T_m = sMC$$

$$P_f = W_{fo} \qquad P_m = W_{mo}$$

$$B_f = W_{f,nbs,mo} \qquad B_m = W_{m,nbs,mo}$$

T Temptation to Defect

P Punishment

B Benefit to Continued Pairing

$$W_{f,divorce,\infty}(L) = T_f + LP_f + L^2 P_f \ldots$$

$$= T_f + P_f \sum_{i=1}^{\infty} L^i = T_f + P_f \frac{L}{1-L}$$

$$W_{f,pair,\infty}(L) = B_f + LB_f + L^2 B_f \ldots$$

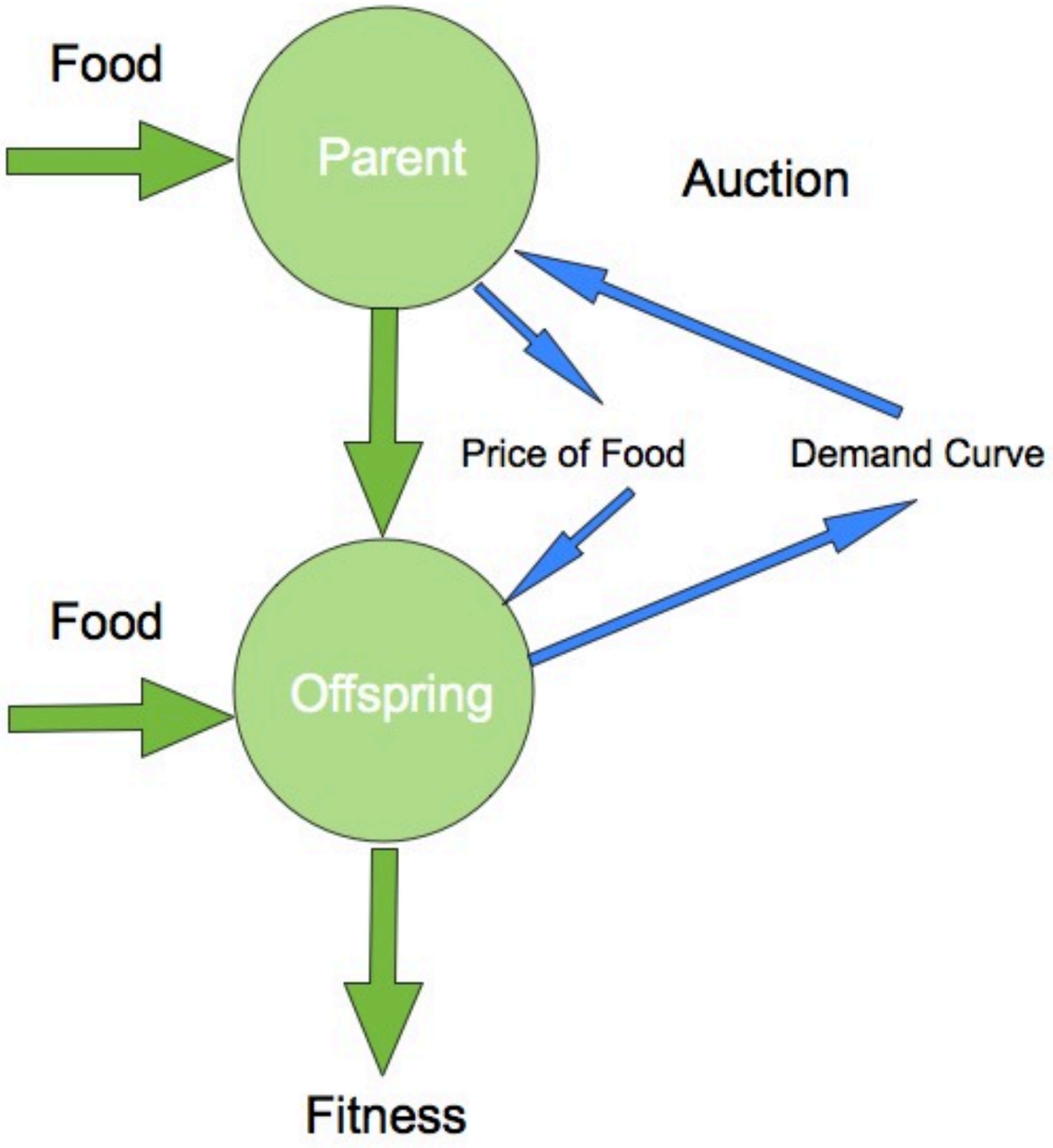
$$= B_f \sum_{i=0}^{\infty} L^i = B_f \frac{1}{1-L}$$

Threshold Daily Survival for Continued Pairing

$$L_{f,min,\infty} = \frac{T_f - B_f}{T_f - P_f}$$

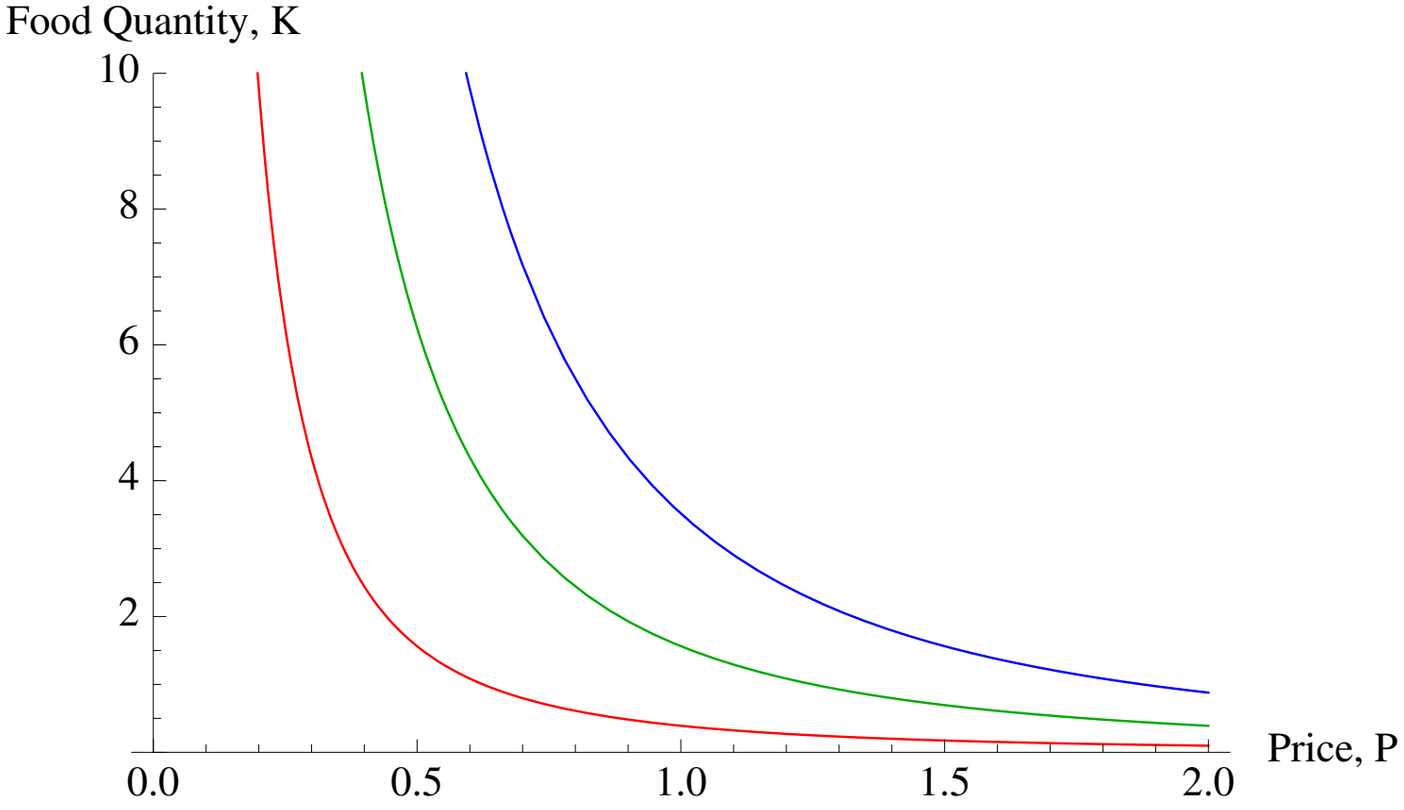
$$L_{m,min,\infty} = \frac{T_m - B_m}{T_m - P_m}$$

Parent-Offspring Firm



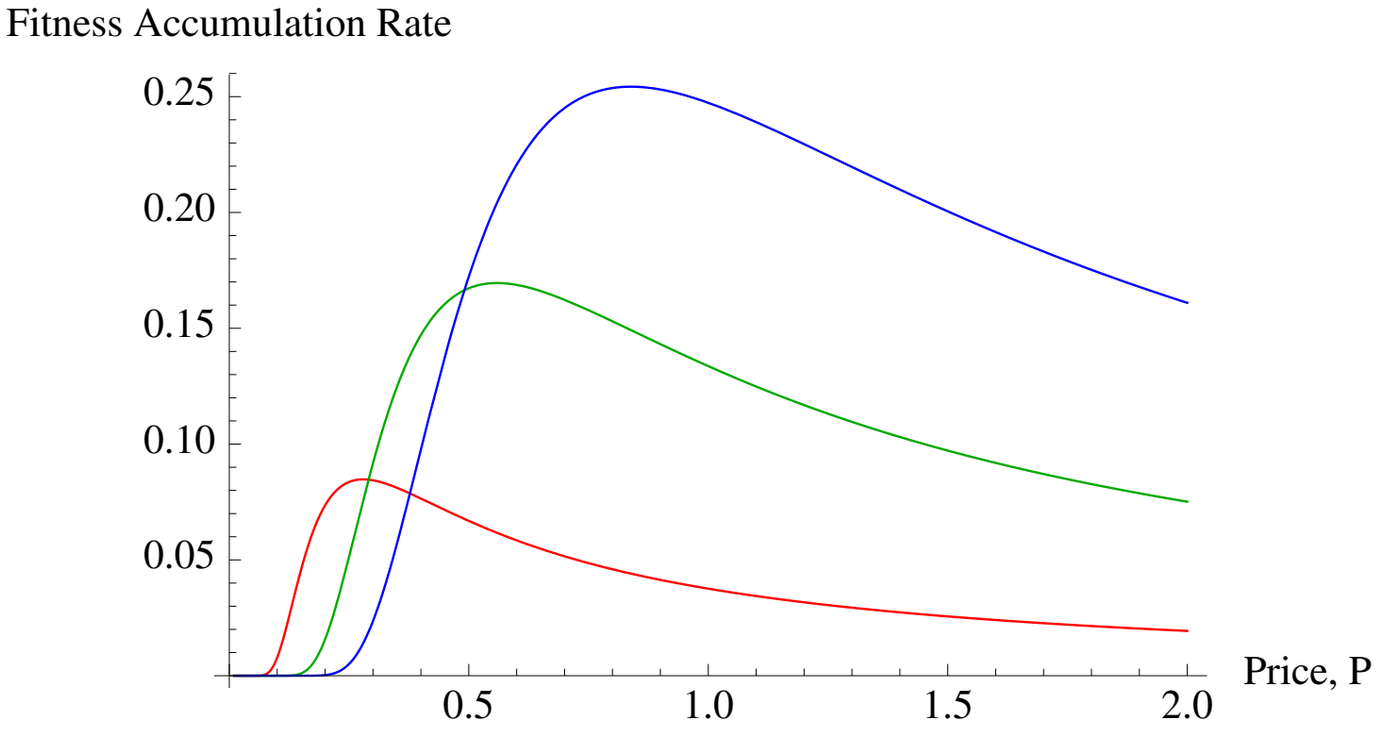
Chick Optimal Demand Curves

Chick Size: Red=Large, Dark Green=Medium, Blue=Small

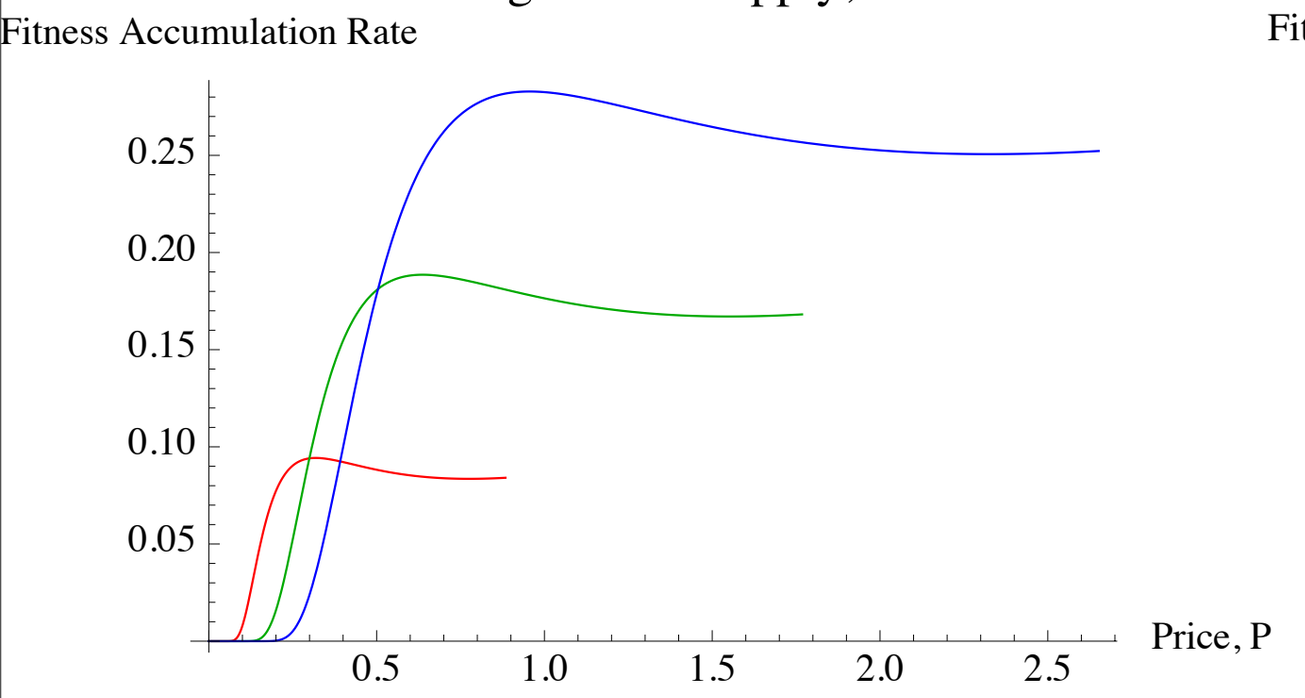


Parental Fitness Production Function,

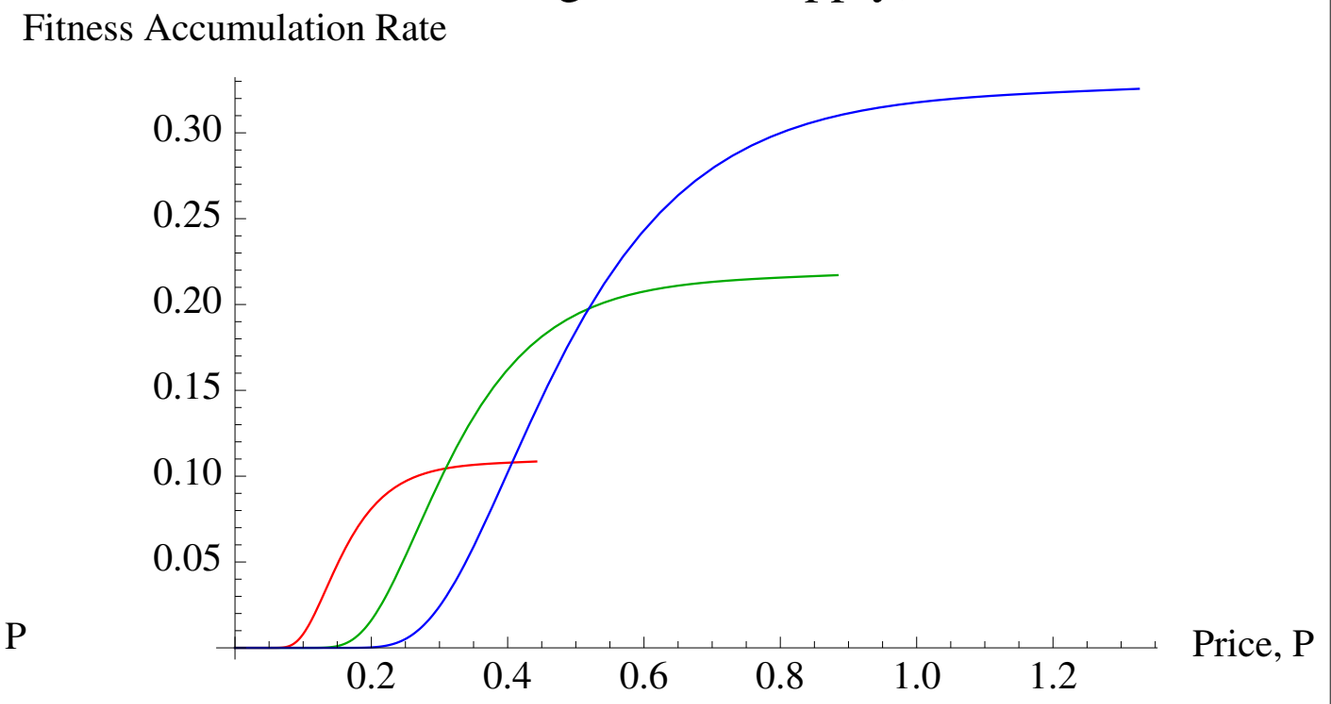
Chick Size: Red=Large, Dark Green=Medium, Blue=Small



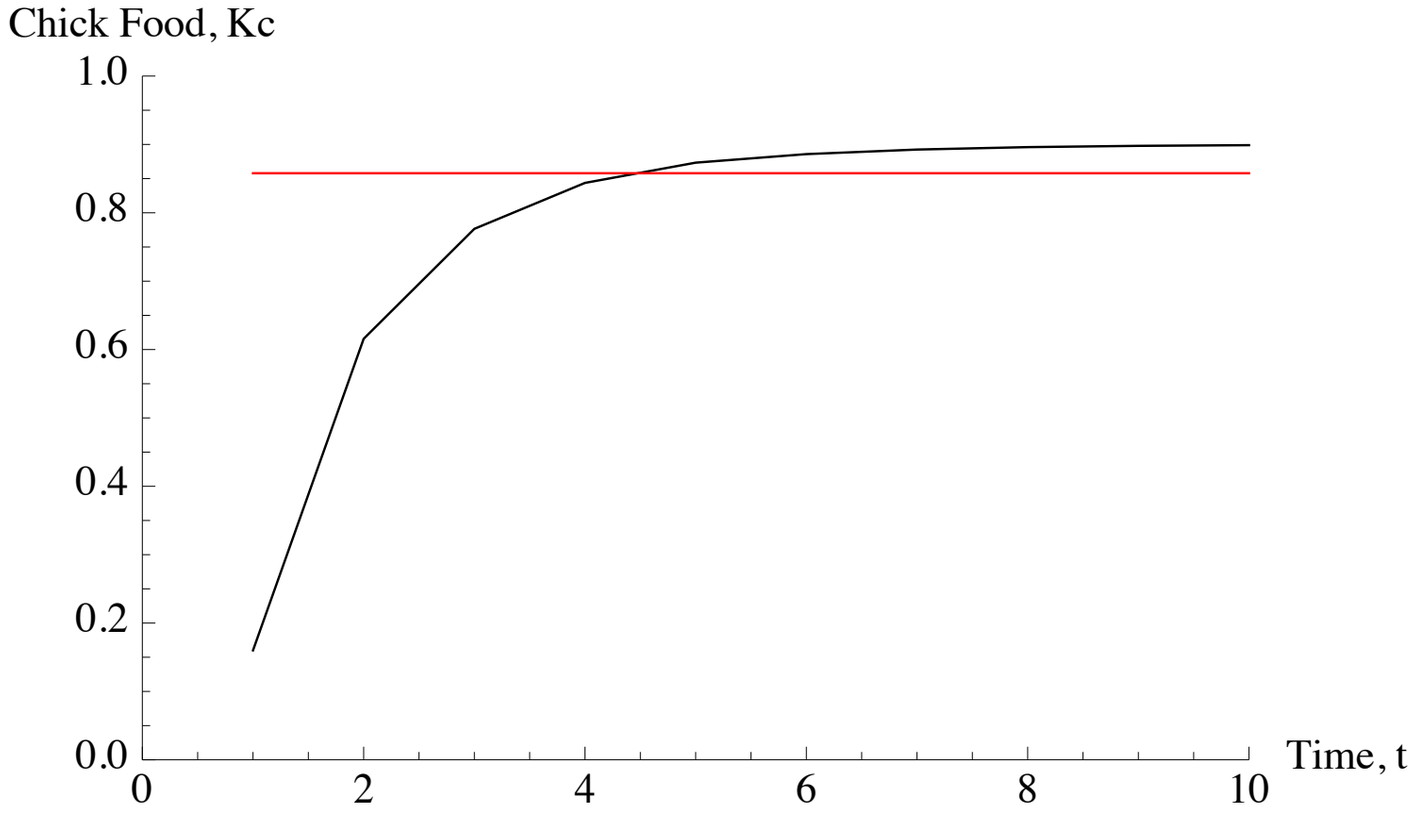
Parental Fitness Production Function,
Chick Size: Red=Large, Dark Green=Medium, Blue=Small
Self Feeding: Chick Supply, Kc = 0.5



Parental Fitness Production Function,
Chick Size: Red=Large, Dark Green=Medium, Blue=Small
Self Feeding: Chick Supply, Kc = 2



Chick Food Procured And Weaning Threshold
Variable Food Supply With Chick Self Feeding



Evolutionary Tier

Genetical Dynamics

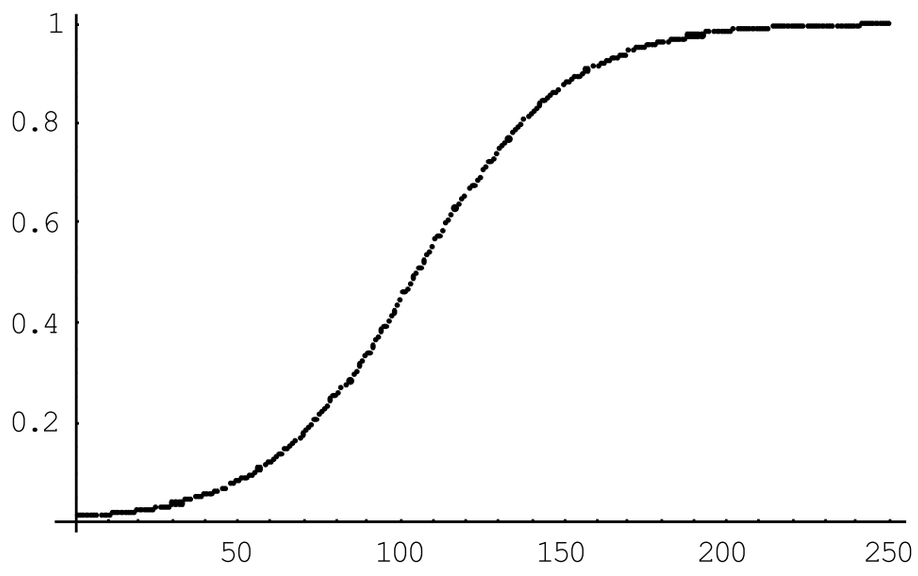
A2A2 x A2A2

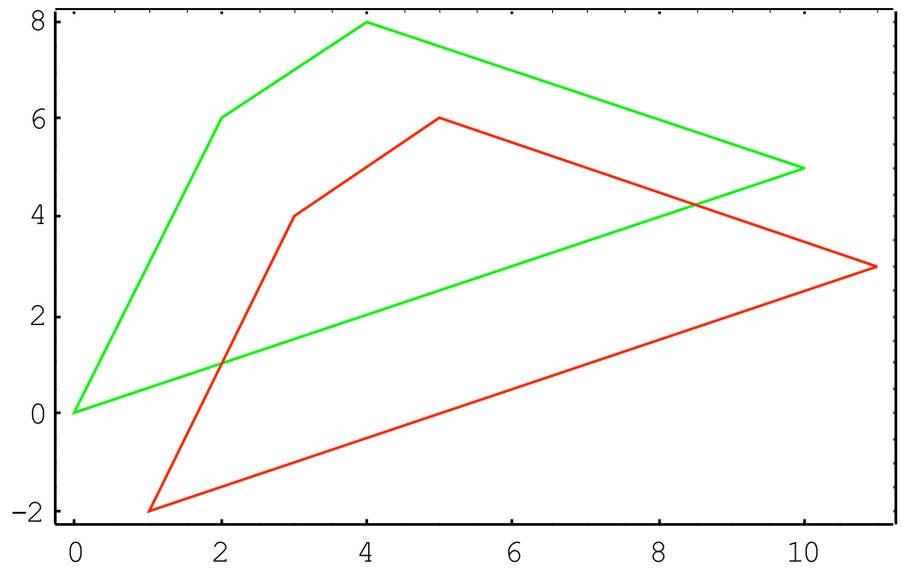
		Cyan 1	Cyan 2
Red	1	(3,4)	(11,3)
	2	(5,6)	(1,-2)

$$p_{t+1} = \frac{a_1}{a_1 + a_2}$$

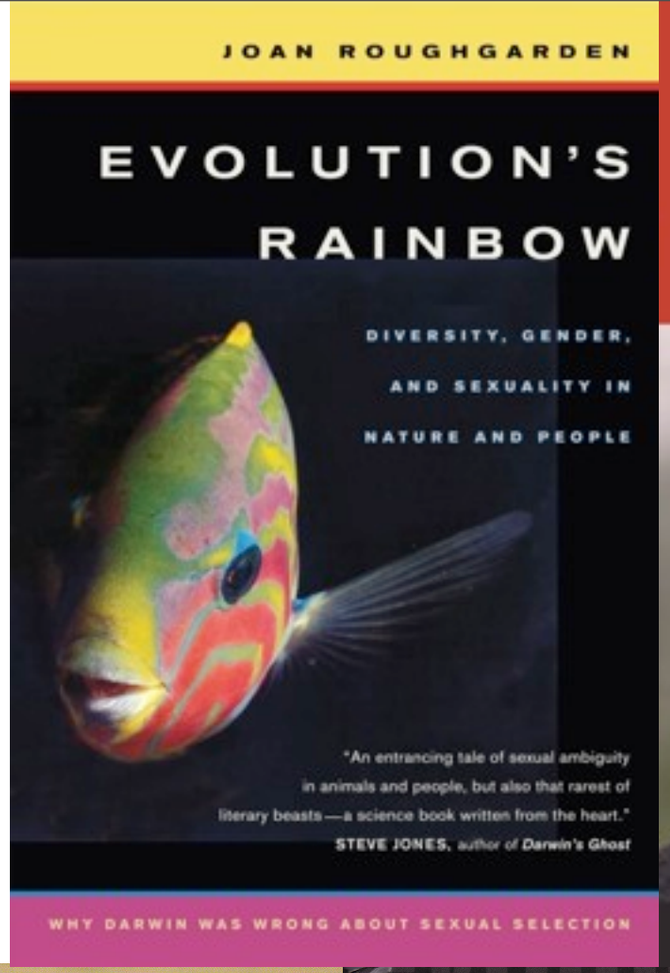
A1A1 x A1A1

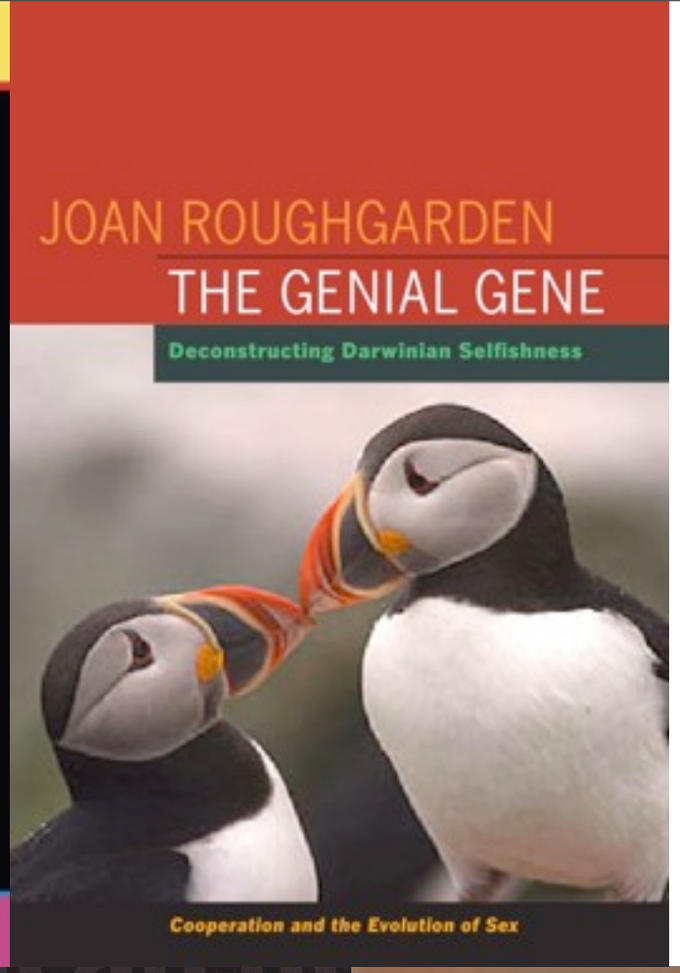
		Cyan 1	Cyan 2
Red	1	(2,6)	(10,5)
	2	(4,8)	(0,0)

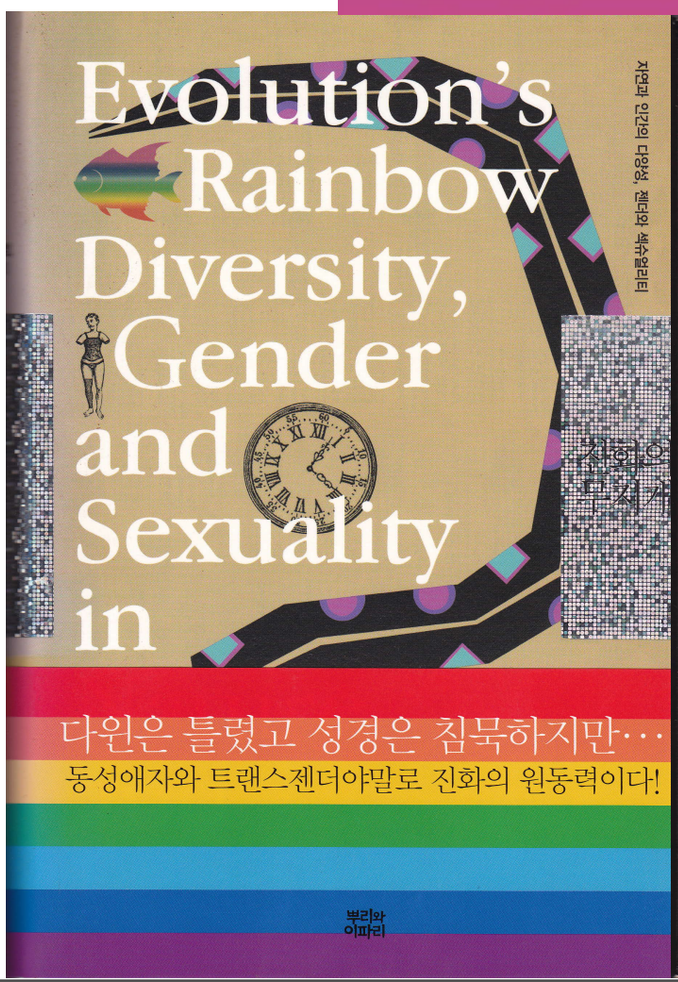


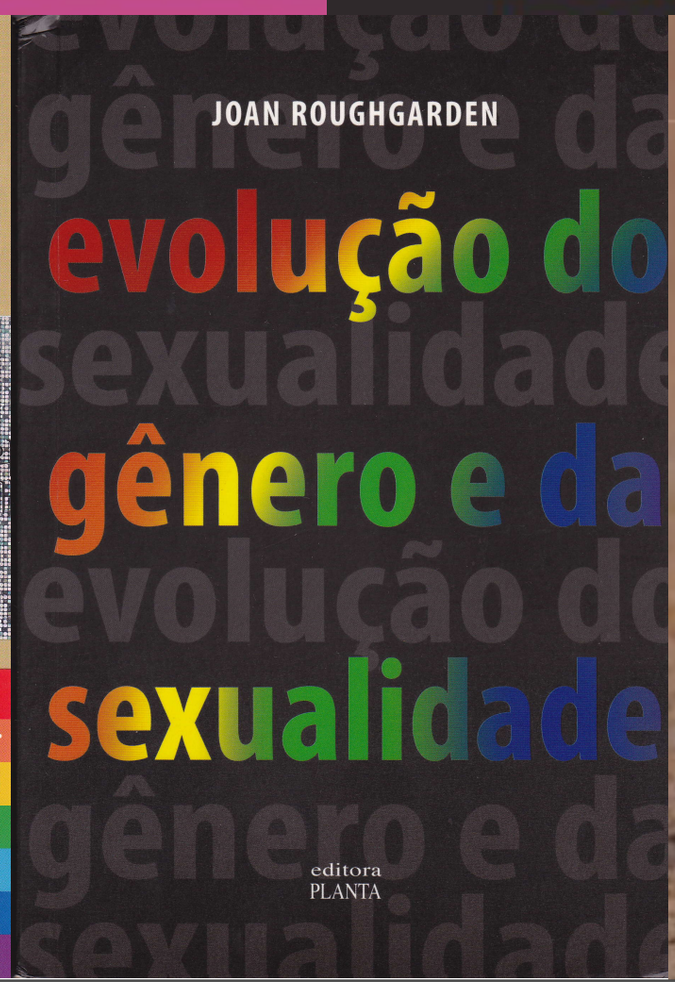


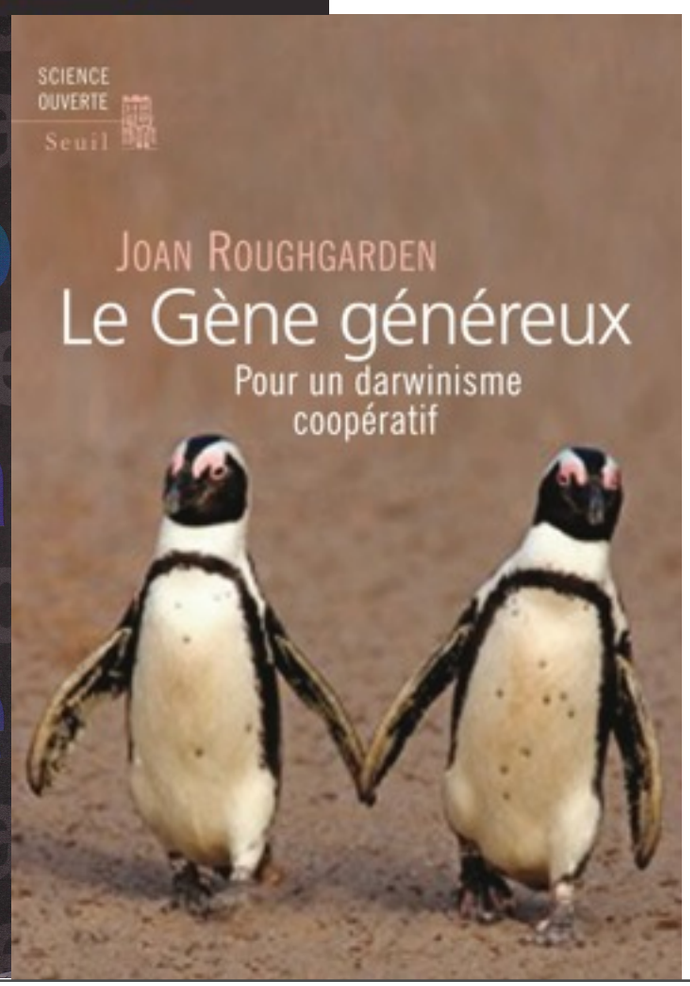
Evolution results in payoff matrix that is ESS, from which behavior emerges.


JOAN ROUGHGARDEN
EVOLUTION'S RAINBOW
DIVERSITY, GENDER, AND SEXUALITY IN NATURE AND PEOPLE
"An entrancing tale of sexual ambiguity in animals and people, but also that rarest of literary beasts—a science book written from the heart."
STEVE JONES, author of Darwin's Ghost
WHY DARWIN WAS WRONG ABOUT SEXUAL SELECTION


JOAN ROUGHGARDEN
THE GENIAL GENE
Deconstructing Darwinian Selfishness
Cooperation and the Evolution of Sex


Evolution's Rainbow
Diversity, Gender and Sexuality in
자연과 인간의 다양성, 젠더와 섹슈얼리티
다윈은 틀렸고 성경은 침묵하지만…
동성애자와 트랜스젠더야말로 진화의 원동력이다!
뿌리와 이파리


JOAN ROUGHGARDEN
evolução do gênero e da sexualidade
editora PLANTA


SCIENCE OUVERTE
Seuil
JOAN ROUGHGARDEN
Le Gène généreux
Pour un darwinisme coopératif