Toulouse School of Economics

TSE M1 – Semester 1

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Evolution of Economic Behavior
Week 9:
Using two locus models to endogenize assortativity

Using two locus models to endogenize assortativity: outline

- The benefits of endogenizing assortativity.
- Preference heterogeneity.
- A model of sexual selection and cooperation.
- Solving the model.
- Conclusions.

The benefits of endogenizing assortativity

- We've seen so far that assortative matching can favor the evolution of altruistic behavior.
- But assortative matching is often the result of choice, and individuals often spend time and resources looking for others with whom to interact.
- We can even model the co-evolution of preferences for altruistic and selfish behavior with preferences for partners with whom to interact.
- An additional benefit of this is that it can help us to understand preference heterogeneity.

Preference heterogeneity

- A robust finding from experimental economics is that some individuals have social preferences (altruism, reciprocity, etc) but not all do. Many do behave selfishly.
- Most papers modeling the evolution of social preferences have tried to explain why there is altruism, not why some people are altruistic and others are not.
- The prisoners' dilemma is not a good model for this as defection is a dominant strategy, unrelated to the other strategies being played.
- To explain polymorphism (coexistence of different strategies) it helps to have payoffs that favor each strategy if and only if it is scarce.

Situations favoring preference heterogeneity

- Policing mechanisms with punishment that is less costly when defection is scarce.
- Public goods games with high then declining private marginal returns to investment.
- Selection mechanisms whereby individuals look for cooperative partners and can find them more easily when they are plentiful in the population.
- We look now at a model of endogenous selection which also delivers preference heterogeneity.

A model of sexual selection and cooperation (joint work with David Pugh and Mark Schaffer).

- A leader (female) chooses two associates (males) who then forage together and receive payoffs depending on their degree of cooperation (Prisoners Dilemma payoffs).
- Two-locus replicator equation with haploid reproduction.
- First locus (α), expressed in males determines altruism (A) versus selfishness (a).
- Second locus (γ), expressed in females, determines strong (G) versus weak (g) preference for choosing altruistic partners.
- Each γ determines a selection function U(γ).

Solving the model.

- The model involves a Replicator Equation, giving the rate of change of the share of each genotype in the population as a function of the fitness of the individuals who express it.

- There are four genotypes: AG, Ag, aG, ag – so since the shares x_1 , x_2, x_3 , x_4 sum to one there are three dimensions to this dynamical system.

- Finding explicit general solutions to this 3-dimensional system is too difficult, but we can solve it for given γ, then ask under what circumstances a genotype γ is uninvadable by other rival genotypes.

- So what does the solution look like for given γ?

Using the Locus of Potential Equilibria (LPE).

- For each value of x_1 (the share of altruists in the population), the LPE gives the value that the selection function $U(x_1)$ would have to take for that share to be an equilibrium.

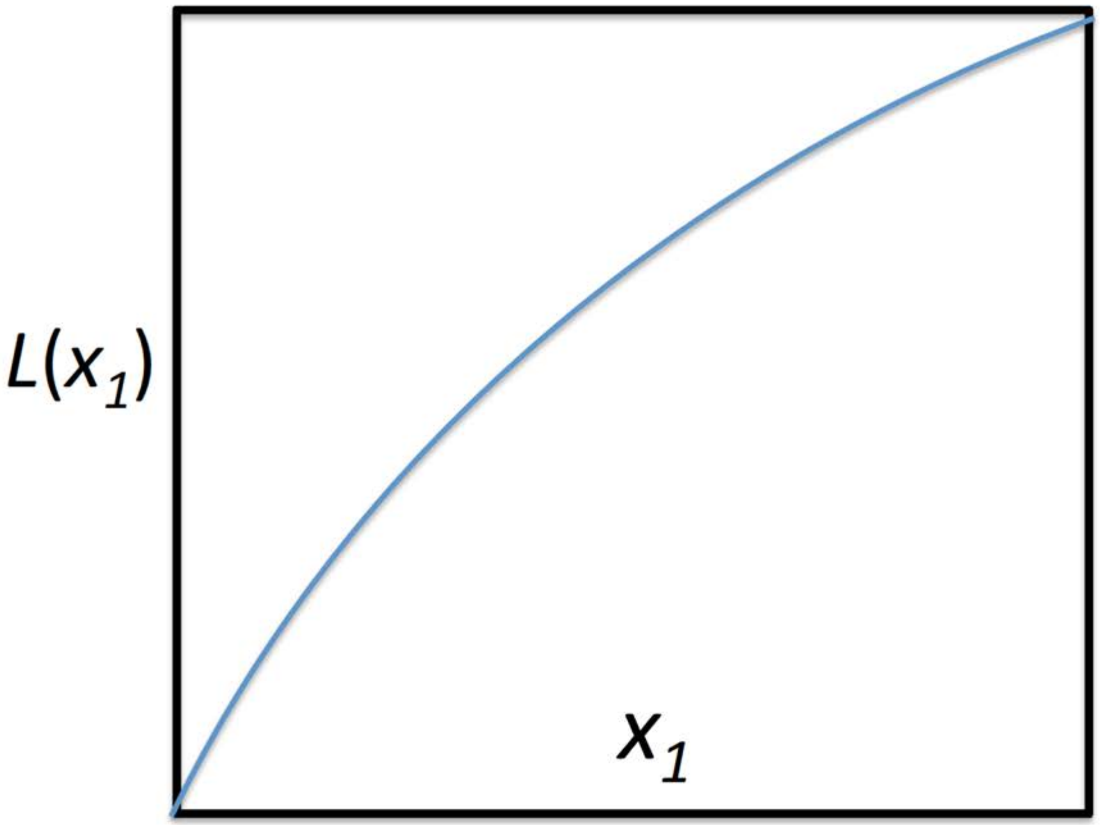
- $L(0)=0$ and $L(1)=1$, and $L(.)$ is continuous in between.

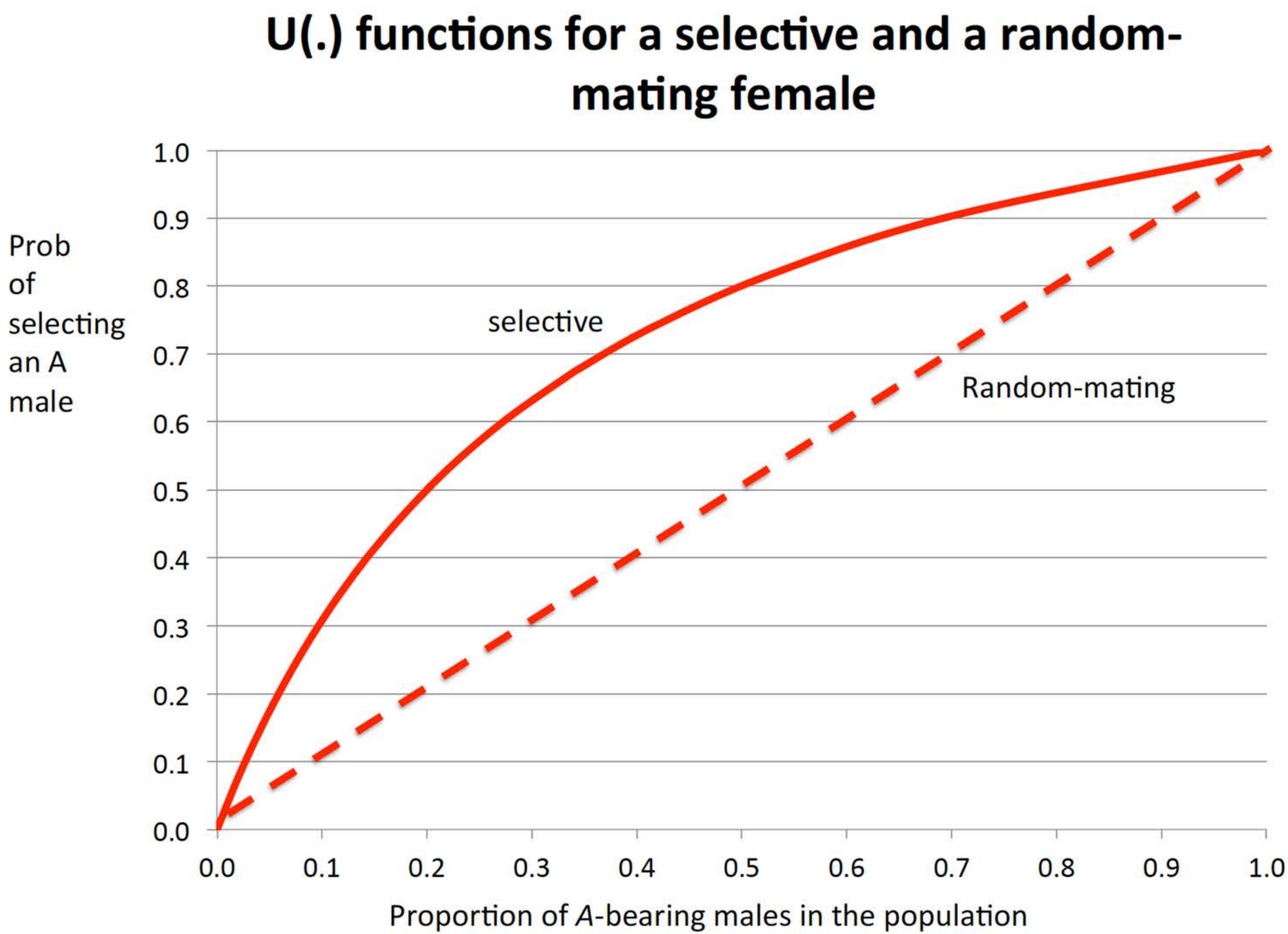
- For Prisoners' Dilemma payoffs it is concave.

- $U(.)$ functions are similarly concave if they are "selective".

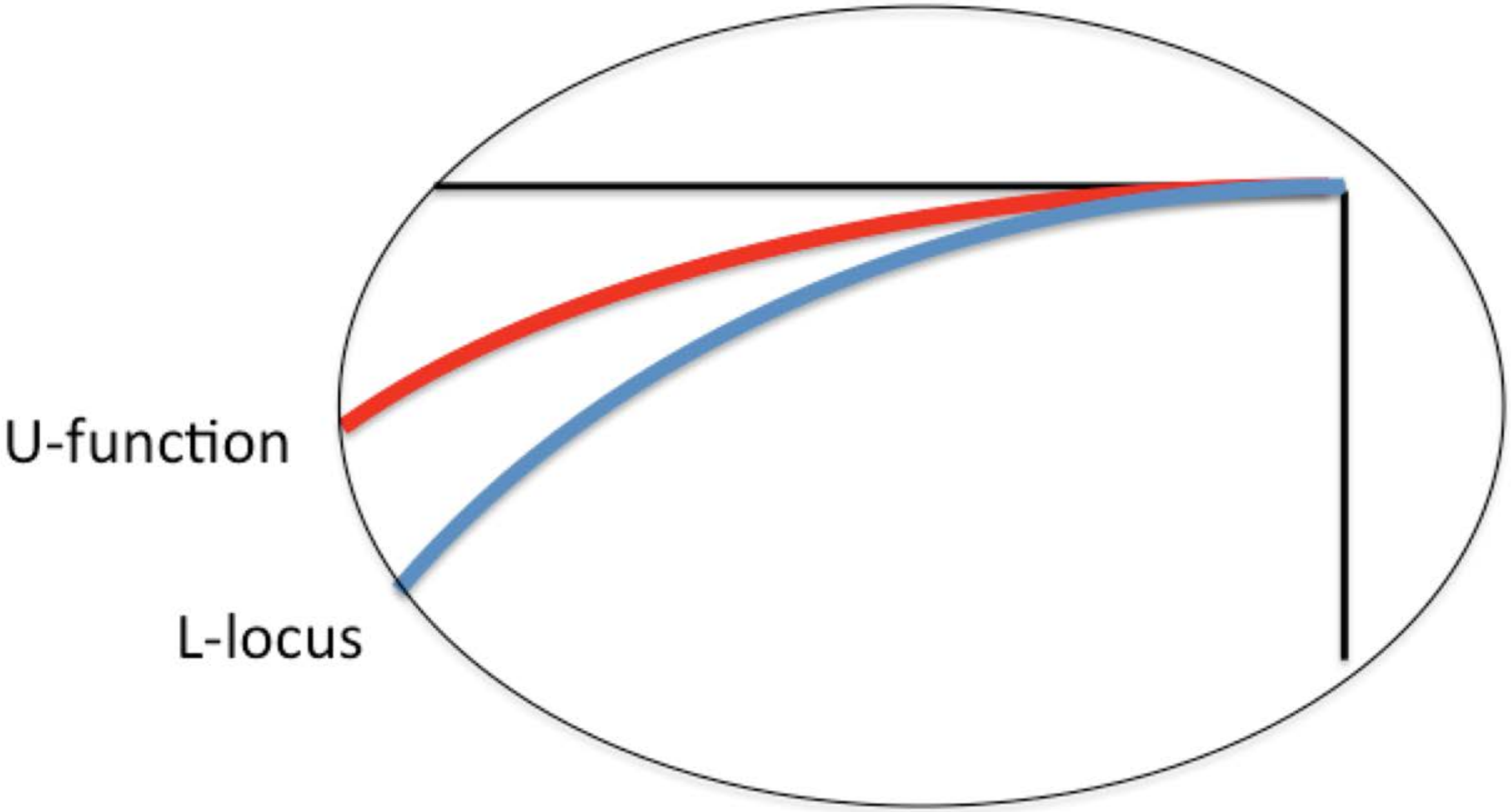
- Then equilibrium will exist with positive share for *any* continuous selection function $U(.)$ that is steeper at the origin than $L(.)$.

L(.) Locus with Prisoners Dilemma payoffs

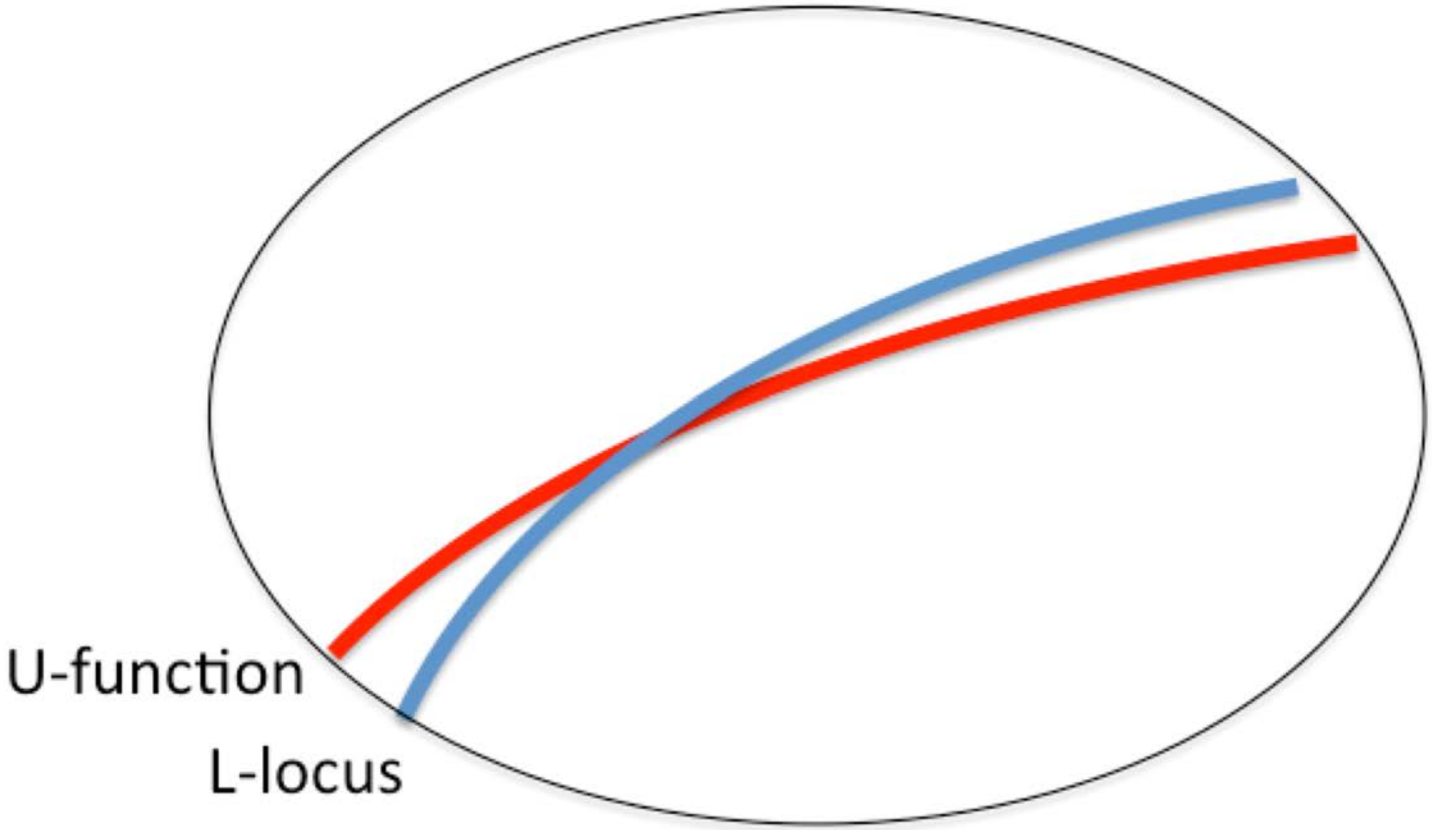



U(.) functions for a selective and a random-mating female
Prob of selecting an A male
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
selective
Random-mating
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Proportion of A-bearing males in the population

Stable corner equilibrium with full cooperation



Interior equilibrium with partial cooperation



Which selection functions will survive in equilibrium?

- It depends on the payoffs – if a pair of altruists produces more offspring than a selfish-altruist pair, then corner equilibria dominate.
- If a selfish-altruist pair produces more offspring than a pair of altruists, then interior equilibria dominate.
- These interior equilibria have mixed populations of selfish and altruistic types.
- If selection functions are metabolically costly, then mixed populations dominate – only if there are enough selfish types in the population will natural selection favor costly screening mechanisms to avoid them.