CHAPTER 6: CHANGE WE MUST: EVOLUTIONARY CONCERNS

I. INTRODUCTION

A. Long-term view: Can cooperation develop through repeated interactions?

B. Will cooperation develop at regional or global level?

C. Will, say, cooperation initiated at the regional level diffuse to other countries and regions?

D. Faced with significant regional and global challenges, successful nations may, like successful species, be those that develop strategies that maximizes their fitness in terms of high payoffs. Behavioral patterns of successful nations are expected to be copied by other nations, thereby spreading throughout a region and, at times, beyond.

E. Cooperators can "colonize" the population of nations and take over. For cooperators to last, they must be immune from invasion by opportunistic "mutants" who employ another strategy.

F. Applied concepts of repeated games and evolutionary games.

G. How might cooperation evolve with time and space?

H. Investigate how evolutionary factors may facilitate successful resolutions to global challenges without the need for a formal supranational structure.

Efficacious strategies, as identified with nations, are self-selected over time through survival and may take over a regional group.

For a particularly threatening global challenge, successful regional strategies should diffuse to other regions and eventually to the entire global community.

II. ON REPEATED GAMES

A. A repeated game is a particular game, complete with its strategies, players, and payoffs, that is played over and over again. Three key ingredients are unchanged from period to period.

B. Figure 6.1 \[T > R > P > S\]
   \[T = \text{temptation} \]
   \[P = \text{punishment} \]
   \[R = \text{reward} \]
   \[S = \text{sucker} \]

C. \[S + T < 2R\] players cannot in total improve upon the aggregate cooperative payoff by agreeing for one to cooperate and for the other to defect and then split the total payoff.
D. Known endpoint: game is played twice. If players look ahead, the dominant strategy in the final period is to defect as $P > S$ and $T > R$. This implies that the dominant strategy in the first round, given the anticipated defection in the second round, is to defect.

E. Figure 6.2 Each individual views the strategic choice in period 1, given the anticipated mutual defection in period 2 with payoffs of $P$ as the matrix in Fig. 6.2.

F. In theory, defection is anticipated in every period when the endpoint of the game or repeated interactions are known.

G. Cooperation is seen more in the laboratory. Also when communication among players is allowed, a greater degree of cooperation is observed. In world of diplomacy, communication is prevalent. Signal cooperation. Signaling falsely may be costly in terms of reputation.

H. Cooperation quite possible if

(1) Repeated interactions have no endpoint
(2) Repeated interactions have an uncertain endpoint.

I. Compare the temptation payoff with the likely consequences or retribution on the defector in the future periods.

Repeated game strategy is a program that indicates, at the outset, the play in each ensuing period. Often the programmed response in a given period depends on the other players’ actions in preceding periods.

Strategies

tit-for-tat: player begins by cooperating and then matches the opponents’ previous-period play. This strategy is not very forgiving. It is applied continuously if the other person defects.

A cooperative response that is misinterpreted can plunge the game into repeated periods of detection until a new mistake is made.

With a 50-50 chance for an error of interpretation, two players using tit-for-tat would cooperate only half of the time on average.

Grim: starts by cooperating and switches permanently to defection following the opponent’s first defection. Completely unforgiving.

More forgiving would be punishing a defection with two or more "tit" for each tat.

Always Cooperate: most forgiving, but easily taken advantage of.
"Tit-for-two tats": player begin with cooperate and defects only after the other player defects twice. Thereafter, the player alters his or her strategy for two consecutive periods. This strategy is more immune to misinterpretations. It performs poorly against opportunistic strategies that take advantage of its forgiving nature. E.g., a strategy that defect in first period and every other round.

**Pavlov**: player repeats a strategy that gives a high payoff and switches from a strategy that gives a low payoff. For PD game, player repeats cooperation after receiving R for a mutual-cooperation outcome. If the player receives T after getting away with unilateral defection, the player then repeats defection. In contrast, the player switches to defection (cooperation) when receiving S (P). Pavlovians respond quickly to correct errors. After one period of mutual payoffs of P, both players switch.

J. **Multiple Nash equilibria - do some game matrices from Collective Action.**

For mutual tit-for-tat, both players cooperate in every period.

**PV of R.**

always defect against tit for tat: in first period receives T and then P thereafter

\[
T + \left(\frac{rP}{1 - r}\right) > \frac{R}{1 - r}
\]

\[
(T - R) > \frac{(R - P)}{i}
\]

K. Known endpoints are analogous to fixed office terms.

L. **n-player games**

(1) Same basic principles

(2) A single defector may be difficult to detect

### III. EVOLUTIONARY GAMES

A. **Evolutionary game theory studies the population dynamics of a repeated game.** Unlike standard repeated games, the number and type of players are allowed to change over time in evolutionary games.

B. If each player type is identified with a strategy (e.g., tit-for-tat), then evolutionary game theory predicts that the "fittest" players will survive, multiply, and eventually take over a population.

C. **Monomorphic**: population of a single type of players

**Fitness** determined by the payoffs that a player receives through its strategy. The likelihood that an agent survives to reproduce is positively related to its payoff received through its interactions.
**Kin selection**: where offsprings interact with siblings in the subsequent period. Strategic choices are programmed by the player’s genetic code and are not a conscious choice.

Can monomorphic populations be invaded or taken over by "mutants"? Stable monomorphic populations can resist invasion, because their payoffs are higher with greater numbers of surviving offsprings. Consider a population of Pavlovians. Can resist tit-for-tat players owing to forgiveness, they can’t resist invasion by defectors.

In simulations, strategies that are more forgiving and cooperative have been shown to be easier to maintain equilibrium for homogeneous populations. Defection go unnoticed for a longer period of time in a large heterogeneous crowding.

Neighbors with similar characteristics and strategies, however, tend to gravitate toward cooperation. Implications for effective responses of nations. Homogeneous regional groups of nations should be better equipped to develop cooperative interfaces.

**D. Evolutionary equilibrium**: is a resting point of dynamic process among diverse types of players where successful strategies or types are able to gain a dominant position by replicating themselves more frequently.

**E.** Altruism may be evolutionary stable because it may maximize payoffs among offsprings. In an evolutionary game, an offspring is anticipated to interact with a sibling or a neighbor. In the case of siblings, there is a high probability that the sibling will share the same genetic code or strategic program.

**F.** Consider PD game. Population of cooperators receiving R. Now suppose a defector mutant comes along and get T > R. In the next period, the mutant interacts with other mutants and gets just P. Over time mutant defector will reproduce less.

**G. Cultural evolutionary games**: behavior towards one’s neighbor is acquired by imitation. Closeness in space or time means that there is a greater likelihood that a player or nation will interact with another that uses the same strategy. Again cooperative populations can be stable.

Imitation can promote altruism and cooperation depending on nearness. Spatial nearness can apply. Or institutional (political and economic) nearness may apply. This might imply that democracies are more apt to form cooperative agreements.

Experimental results imply that small regional collectives of nations with similar characteristics are more likely to evolve to a cooperative equilibrium than large heterogeneous groups.
IV. EVOLUTIONARY GAMES AND GLOBAL CHALLENGES

A. Cooperation for local problems
   (1) Greater cultural inheritance
   (2) More communication
   (3) Smaller numbers
   (4) Longer time horizon for interactions
   (5) Historical profile

B. Cooperation for global challenges
   (1) Enclaves of cooperator
   (2) Contagious cooperation
   (3) Importance of leader nations

Cooperation will begin at the local or regional level especially among nations at identical stages of development with similar economic and political systems.

Evolutionary theory provides less hope for problems like global warming involving a diverse large group. Limited communication, unlikely to cooperate in ensuing period, culturally separated, limited altruism.

Contrast with CFCs.

V. EVOLUTION AND THE EFFECTS OF INCOME DISTRIBUTION

A. More inequality with time

B. Leader nation will be the well-to-do

C. **Best shot**: wealthy nation if surrounded by poorer nations, then the wealthy nation will provide the needed boost. Problematic if regionally there is no stand-out nation.

D. **Weakest Link**: more cooperation if all are equal in income bode well for regional problems and evolutionary equilibrium.

E. **Summation**: better evolutionary results if greater inequality.