

LEARNING FROM SCHELLING'S STRATEGY OF CONFLICT

by Roger Myerson 9/29/2006

<http://home.uchicago.edu/~rmyerson/research/stratcon.pdf>

Strategy of Conflict (1960) began with a call for a scientific literature on deterrence and strategic conflict.

Schelling noted that the field of game theory seemed well placed to become such an analytical science of strategy, but that its promise was then unfulfilled, being pitched at an unhelpful level of mathematical abstraction.

In 2005, Schelling won the Nobel prize with Robert Aumann, for helping game theory to fulfill this promise.

In honoring Thomas Schelling today, I speak as one from the methodological (Aumann) side of the field.

I would like to address three points in my short talk:

- (1) the importance of Schelling's work for the development of game-theoretic methodology;
- (2) the significance of Schelling's focal-point effect for defining the scope of economics and its connection to other social sciences;
- (3) the continuing importance of Schelling's ideas for the international relations of our troubled times.

Any analytical discipline needs some general framework, for making connections between different applications.

Modern game theory begins with von Neumann's (1928) definition of three general ways to represent games.

von Neumann argued that general dynamic games in extensive form can be reduced to a one-stage normal form, in which players simultaneously choose strategies, which are plans of action for all observable contingencies. He then reduced games with >2 players to coalitional form, specifying only what each coalition can guarantee itself.

The argument for normal-form generality led Nash (1951) to see noncooperative eqm as a general solution concept. But most 1950s game theorists followed von Neumann's emphasis on cooperative coalitional-form analysis. Nash eqm became the dominant analytical methodology only after Harsanyi and Selten, in 1960s, extended it with Bayesian eqm for incomplete-information games and sequentially-rational perfect eqm for extensive games.

In Harsanyi's published work, the first indication of any interest in noncooperative game theory is a 1961 footnote where, in response to Schelling's criticism, Harsanyi promised to extend his work to noncooperative games.

Selten's first (1965) analysis of sequential rationality begins with a footnote acknowledging that

"the great strategic importance of an ability or inability to make firm commitments was first pointed out by Schelling (1960)" (repeated in English in Harsanyi and Selten's 1988 book).

So Schelling was a vital link between Nash's early work and the later developments of Harsanyi and Selten, who were just two of the many readers deeply influenced by Strategy of Conflict.

Schelling (1960) analyzed equilibria of normal-form games, but he had no use for the coalitional form, which suppresses individual decisions, as he saw (like Nash) that the sequence of bargaining moves can be crucial.

From the perspectives of Nash and Schelling, we can see that negotiating joint expectations of focal equilibrium may be the only sense in which players can truly "co-operate", because their understanding of the eqm must be shared jointly.

The importance of information and timing of individuals' decisions was repeatedly emphasized by Schelling (1960), but reduction to normal form tended to suppress questions about information and timing in games.

Thus, *Strategy of Conflict* demonstrated both the importance of noncooperative equilibrium analysis and the inadequacy of doing it only in the normal form.

To match the scope of Schelling's analytical examples, game theorists had to develop Bayesian equilibria (Harsanyi 1968), correlated equilibria (Aumann 1974), and sequential equilibria (Selten 1975, Kreps and Wilson 1982).

Given any game, a prediction of players' behavior which is not a Nash equilibrium cannot be commonly believed, because if everybody believed it then at least one player would want to violate the predictions himself.

So when we study a game that has only one equilibrium, it must be the only rational prediction of players' behavior, and then game theory seems very powerful.

But many games have an embarrassing multiplicity of equilibria. Admitting multiple equilibria in games seems to threaten economists' vested interest in economic determinism.

Schelling (1960) saw such games with multiple equilibria as a pervasive fact of life to be appreciated.

Anything that focuses the players' attention on one eqm may lead them to expect it, and so rationally to play it.

This focal-point effect opens the door for cultural and environmental factors to influence rational behavior.*

Truth, justice, law, legitimate authority, reputational status, and relationships of trust can all be understood in terms of social selection among multiple equilibria.

Schelling's focal-point effect should be counted as one of the most important ideas in social science.

^{*}(The other way to bring cultural effects into economic analysis is to assume that individual preferences are culturally determined. With endogenous preferences, one might "solve" social problems by teaching the poor to love poverty, or by teaching the powerful to love social justice. Economic analysis of institutions would be trivialized by such an assumption that individuals could be culturally reshaped to fit institutional requirements.)

Harsanyi wanted to extend decision theory by a strong rationality axiom: that rational behavior should depend only on the payoffs. So to define strong rationality in games, Harsanyi and Selten sought a natural rule for selecting one unique equilibrium in every game, depending only on the players' payoffs in the game.

Schelling responded that any theorist may see his eqm-selection theory as self-enforcing, once generally accepted.

Imagine we tried to get people to play our selected eqms. Trying to change principles of focal coordination in a society is politics. In this sense, Harsanyi and Selten (1988) were trying to define a neutral political theory based on a new kind of natural law.

Schelling's response extends Hume's observation that general public opinion may be the only standard for questions of morals.

To show how multiple equilibria provide economic foundations of political institutions, let me review my favorite social model, of an island where people are randomly matched each day to play rival-claimants games with $V > 0$, $c > 0$: (E.g., $V = 99$, $c = 1$)

	Player 2 claims	Player 2 defers
Player 1 claims	$-c, -c$	$V, 0$
Player 1 defers	$0, V$	$0, 0$

When the game is played once, we find three equilibria:
 (1 claims, 2 defers) yielding payoffs $(V, 0)$;
 (1 defers, 2 claims) yielding payoffs $(0, V)$; and
 each independently randomizes with $P(\text{claim}) = V/(V+c)$,
 yielding payoffs $(0, 0)$, as $[-c]V/(V+c) + [V]c/(V+c) = 0$.

A social process of repeated play yields many kinds of equilibria:

1. They may always play the symmetric randomized eqm ($E\$=0$).

This is the anarchic state of nature.

2. In a match, symmetry may be broken by shared understanding (justice) of who should claim here (ownership rights).

Note: game models of self-enforcing ownership must have multiple equilibria, or else ink spots could not transfer it.

3. Where claiming rights are unclear, a mutual friend could arbitrate, perhaps by tossing a fair coin.

But the loser might demand another toss, or a higher authority.

For unquestionably final arbitration, they could use a divine oracle.
(Societies regularly use the divine for focal coordination.)

4. In an assembly, players may establish rules that define ownership claiming rights in more situations (legislation).
5. A generally recognized leader may allocate ownership rights in cases not covered by traditional justice or legislation.

Common recognition of law and authority gives their rulings force. Leaders may be identified by any election procedure, and their authority could have any recognized limits (constitutionalism).

Danger of anarchy makes selection of leadership a coordination game with multiple equilibria, but it is the equilibrium-selection problem to solve all other equilibrium selection problems.

Focal coordination may be assured by the recognized blessing of the divine spirit of the Universe on our leaders.

Assuming payoff is reproductive fitness, by Darwinian dynamics, cultures with effective systems for focal coordination should have covered the world.

We should expect equilibrium play in most games to be guided by systems of culture and authority.

(But when invaders eliminate generally accepted leadership without imposing their own system, anarchy may be expected.)

So games with multiple equilibria show the economic importance of focal coordination by culture, politics, and religion.

In this sense, the focal-point effect has redefined the boundary between economics and other social sciences that study culture and politics.

Schelling (1960) emphasized the question of how rational agents can commit themselves to costly threats and promises (which benefit agent only in anticipation by influencing others). A player who expects to win many future rival-claimants games could become committed to costly public actions in other areas by an expectation that his deviation could change subsequent rival-claimant play to an equilibrium where he always defers. So failures of commitment can be punished in repeated games by a change of play to an eqm worse for the deviator (Folk Thm). Multiple equilibria are essential here, for a deviation to change behavior without any material change in the players. These different equilibria may be interpreted as different kinds of reputations and relationships among the players. So commitment is achieved by reputations, and reputations involve multiple equilibria.

My understanding of international relations has been shaped by Schelling's ideas (...need to consider rivals' rational incentives, and to analyze contingent strategies in coordination with rivals). In the 1960s, he showed the vital importance of strategic communication among nuclear powers.

In the 2000s Americans ask, how can we reduce militant radicalism in the Middle East and around the world?

From Schelling, we should learn to ask:

Why might rational citizens prefer leaders who are committed to costly military actions?

They could have two possible motivations for such militarization:

- to profitably attack others, but such profitable aggression is rarely feasible (for any but the greatest powers);
- to decrease chances of being attacked, which can be a strong motivation anywhere.

So to decrease our neighbors' incentives to militarize against us, we want to reduce their fears of being attacked.

Forceful acts without strategic limits counterproductively increase our unconquered adversaries' commitment.

We can benefit from a reputation for accepting strategic limits on our use of force, using proportionate retaliatory force only as necessary for deterring attacks on us.

But strategic communication is essential, as always.

Our strategic limits must be clearly communicated to potential adversaries, as our reputation is in their eyes.

For questions of whether our use of force has been appropriate under our strategy of conflict, the ultimate judge and jury are the potential rivals whom we want to deter and reassure.

From this perspective, unprecedented invasions and a presidential policy of admitting no limits on our use of force would seem to be a dangerous repudiation of strategic limits, which is likely to inspire counterforces (from nuclear to guerrilla, depending on local capabilities). Israel's retaliation in Lebanon this summer also lacked any clearly articulated limits or proportionality to the provocation. So Hezbollah's Nasrullah can pose as Lebanon's strongest defender, calling 1200 recent deaths a small price to avoid Iraq's fate of "10000 to 15000 people killed every month in a chaotic war incited by the Americans and the Mosad." Conversely, Arab calls for total elimination of Israel motivate Israelis to bear the high costs of their militarization.

As a theorist, perhaps I should avoid such applied policy analysis, especially as it is flawed by inconsistency:

Intelligent rational people (American voters) should not systematically ignore the benefits of accepting strategic limits.

Everyone should recognize that restraint is as important as resolve, because force is effective only in a strategy that includes both.

Perhaps the imperative to strengthen social coordination by finding divine blessing for the prevailing norms of justice in each nation might make each nation blind to doubts about the benign justice of its own foreign policy?

But speculation about inconsistent perceptions takes me beyond my own methodological limits in game theory.

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Marketing militant political leadership to a rational audience?

"How many were martyrs?

Never mind, were they 1,000 or 1,200 martyrs?

In Iraq, some 10,000 to 15,000 people are killed every month in a chaotic war that is administered, financed, and incited by the Americans and the Mosad.

The resistance in Lebanon protected Lebanon from civil war."

"Some say that the resistance in Lebanon pushes for civil war.

Never! Had Israel won, Lebanon would have been pushed to civil war, and you would have heard voices calling for federalism, cantons, and division. The Israeli language would have become current anew."

Hasan Nasrullah, speech of 9/22/2006

<http://www.juancole.com/2006/09/nasrullahs-speech-here-is-bbc-world.html>