E C O N O M I C S B U L L E T I N

An interview with Thomas C. Schelling: Interpretation of game theory and the checkerboard model

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Abstract

This note is mainly based on a short interview with Thomas C. Schelling (TCS), who shared the Nobel Prize with Robert J. Aumann in 2005. The interview took place on 06.03.2001 at University of Maryland, College Park, USA. It consists of two parts. The first part is about his interpretation of game theory, particularly about the use of game−theoretic models in explaining the origin and maintenance of conventions, and norms. The second part is on the origin of Schelling's influential checkerboard model of residential segregation, particularly about his approach to modeling social phenomena exemplified by this model. The note ends with some concluding remarks.

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1. Introduction

This note is mainly based on a short interview with Thomas C. Schelling (TCS), who shared the Nobel Prize with Robert J. Aumann in 2005. The interview took place on 06.03.2001 at University of Maryland, College Park, USA. It consists of two parts. The first part is about his interpretation of game theory, particularly about the use of game-theoretic models in explaining the origin and maintenance of conventions, and norms. The second part is on the origin of Schelling's influential checkerboard model of residential segregation, particularly about his approach to modeling social phenomena exemplified by this model. Each part starts with a short introduction. The note ends with some concluding remarks.

2. The Interpretation of Game Theory

The classical interpretation of game theory is that games should represent the physical and institutional rules of the game in the real world. Yet game-theoretic models do not generally reflect the physical and institutional rules in the real world, rather the rules of the game are usually the invention of the theorist (Janssen1998: 23). That is, game-theoretic models do not provide a description of the environment within which a particular result (e.g., a particular convention) has emerged, they rather abstract from such factors. An alternative interpretation is that 'to make sense a game should present the way in which individuals (players of the game) conceive the situation' (Rubinstein 1991). Of course, game-theoretic models portray the way in which *model agents* perceive the hypothetical scenario described by the theorist. Yet they do not represent the way in which real individuals perceive the problem situation in the real world. Rather, most of them represent the way in which (hyper or boundedly) rational agents *may* perceive the conjectured situation. Moreover, most of evolutionary game theory (e.g., replicator dynamics) portrays individual agents as pre-programmed machines. Hence, the perceptions of the real agents have no role in these models. Generally, the theorist presumes that agents would perceive the situation in a certain manner and then examine the results of this presumption. Thus, the interpretation that games represent how agents perceive the situation does not apply.

Thomas C. Schelling provides another interpretation of game theory. He argues that it provides a *framework for analysis* (e.g., see Schelling 1984a). He suggests that game theory does not describe "how people make decisions but a deductive theory about the conditions that their decisions would have to meet in order to be considered rational" (Schelling 1984a: 215) it may be "valuable not as 'instant theory' just waiting to be applied but as a framework" (Schelling 1984a: 241).[1] Schelling thinks that "game theory is intellectually useful, but at the most elementary level." Given this remark it is interesting to know what he thinks about "advanced" game theory.

2.1. Interview: Part I

NEA: In your interview with Richard Swedberg (1990) you say that "game theory is intellectually useful, but at the most elementary level." What do you mean by "intellectually useful" and why at the most elementary level? Can you please explicate that?

TCS: In general, when I am thinking about threats and promises, institutional arrangements for making commitments, things like exchange of hostages, and problems like the surprise attack problem, I found that elementary game theory—so elementary that I hardly want to

[1] Also see Binmore *et al.* (1993a: 8) which argues that game theory is a tool of investigation. It is like thought experiments in that it helps us conjecture about the type of theorem that might be true.

call it game theory, just being able to identify questions, outcomes, payoffs, and maybe putting them into a matrix – was extremely helpful. I am teaching classes now, I can give the students a very simple problem, and they just can not possibly handle it. And I say, “look, you have two individuals, each has just a pair of choices, we can make a matrix, with four cells, four outcomes”, and I tell them, “look at it and now tell me what you see.” Pretty soon they learn to look for dominant strategies, they learn to look at equilibria, they learn to conceive if one has a dominant strategy, what that does to the other’s choices. They can talk about whether it makes any difference if they choose simultaneously, or if one goes first. All these things they can talk about suddenly. Before they had the matrix they did not know how to arrange the data of the problem, so they could visualize it or manipulate it.

I use the following analogy: the greatest advance in business management is double-entry bookkeeping, and the greatest advance in mathematics is the equal sign, the algebraic concept. I think the greatest contribution of game theory has been the payoff matrix. The payoff matrix, even a payoff matrix that is infinitely large if the choices are ordered, gives so many ways to see the structure of the problem. I would say, just the payoff matrix for the people in sociology, political science, law, and economics, can be immensely important.

Going on from there you can develop some concepts, like the equilibrium concept, the concept of dominated or dominant strategies, the idea of multiple equilibria, the idea that sometimes you can find solutions by casting out successively dominated choices. All of these things I find very helpful, and I teach them to the students. I tell them “someday you may find this useful.” About equilibrium, you think of it as simply a pair of expectations that lead to the behavior that fulfill the expectations. This is so elementary that nobody would ever give it a name like game theory. There are all kinds of concepts that do not get such cute names.

I have about twelve books on game theory, but only a couple of them that I find useful to me as an economist. (That's not counting Duncan Luce and Howard Raiffa's "Games and Decisions," 1957, which is about the most useful book I ever read.) Most of them I find to be so entranced by very sophisticated concepts, but it is very hard for them to find any applications. David Kreps, at Stanford, does useful work, and Roger Meyerson, at Northwestern, and they, I think, try very hard to make game theory accessible to a student, to show how it can be used. People keep saying that game theory revolutionized economics in the last fifteen or twenty years. I really do not see that. It is partly that, much of what they do is hard for me to read and understand, and usually do not bother. There may be more there then I can appreciate.

But if you look at the Journal of Conflict Resolution, which started in 1957, and it has published a lot of very elementary game theory. In fact it used to have a regular section on game-theoretic ideas. You can look through there, and you could see a lot of game theory, but all extremely elementary stuff.

NEA: So, then, what do you think about ‘evolutionary game theory’ and its applications in social sciences, like Peyton Young’s (1998) works. They seem to be extremely sophisticated, and they use advanced mathematical techniques.

TCS: I was fascinated by Maynard Smith’s work. I thought it was terrific. I like Peyton Young’s work. I think he remains too pure. He talks of this evolutionary process that brings about norms. Then he works the model and discovers that, because he has a lot of stochasticity to begin with, inevitably if you wait long enough the norm will break down. What I tell Peyton is, once you got the norm people are no longer trying to make decisions the way they make them before there was a norm. Now people are going to notice the norm. If the norm is a man always opens the door for a woman, once you have the norm pretty soon

all children will grow up knowing the norm, so the stochastic process that led up to the norm yields to the fact that once you have norm people can internalize the norm, they can remember the norm, they can teach the norm, they can even put signs expressing the norm. Therefore, a lot of this fascinating work about how if you wait a million years the norm may break down, strikes me as not nearly as interesting as the fact that the norm can arise in the first place. Most of the norms I abide by I do not abide by because the last twelve times I abided by them they worked, and therefore they will probably keep working.

But I like his work. I also like some of Ken Binmore's work, although I do not see lot of this type of work. Young and Binmore are not really much interested in simulation—compared with models that have solutions. But Peyton does take that very seriously.

NEA: Of course, the game-theoretic treatment of conventions and norms began with David Lewis's (1969) work and economists, such as Robert Sugden (1986), followed his lead. What do you think about this other trend in game theory?

TCS: David Lewis was my student once. I think he got the idea from taking a course from me, and then he wrote his whole book on it—which is a very nice book. And there is Robert Sugden, who mainly uses solvable models rather than simulations. But I enjoy his work. Sugden, I think, has a political interest, sort of a libertarian interest, in showing that you do not need government. I do not think of these people as game theorists but as social theorists. If they did not tell you that they were using game theory, you would simply read it and say "this is theory—this is what social scientist does". It tends to look a little more like economics then like sociology, or political science, or anthropology, because economists, since the time of Cournot, are engaged in this kind of analysis. But you do not need to call it game theory. Somebody could do what Peyton Young does, and he may never have heard of game theory.

If you want game theory to be only theory of conventions, then I think it is hopeless. If you want to see whether game theory can be of any help in thinking about which conventions come about, how they come about, how durable they may be when they come about, then I think game theory can help. But game theorists want the whole theory to be game theory.[2]

3. The Checkerboard Model

Thomas Schelling is awarded with the Nobel Prize "for having enhanced our understanding of conflict and cooperation through game-theory analysis." Of course, he has contributed much to our understanding of coordination, cooperation and conflict. Yet he has also contributed much to our understanding of the dynamics of residential segregation. In a series of papers and in *Micromotives and Macrobehavior*, Schelling (1969, 1971a, 1971b, 1972, 1978) argued that residential segregation can be compatible with different micromotives; and *even* mild segregationist preferences (e.g. trying to avoid a minority status) can bring about residential segregation (see Aydinonat 2004). Thus, he proposed that residential segregation could emerge as an unintended consequence of human action. Schelling's checkerboard model of segregation is regarded to be one of the examples of good explanation in social sciences (e.g. Sugden 2000) and the classical account of explaining with social mechanisms (e.g. Cowen 1998: 126). It is also considered as one of the paradigmatic examples of *invisible*

[2] Prof. Schelling also mentioned that he was not satisfied with the theory of focal points, because game theorists were not interested in the real life consequences of focal points. When we were discussing the theory of focal points we concluded that the theory was flawed because it left out the conventions, and became a theory about coordination games with objects where the focal point is the result of the oddity of one of the objects (the odd one out).

hand explanations (e.g. Nozick 1974, 1994; Ullmann-Margalit 1978) and one of the predecessors of *agent-based computer models* (e.g. Epstein & Axtel 1996, Rosser 1999, and Casti 1992). Consistent with the sprit of Schelling's other works, the checkerboard model is a simple, intuitive and influential model. Since our interest in this interview is with the methodological underpinnings of Schelling's work it is appropriate to ask how Schelling came up with this model. The checkerboard model is very similar to cellular automata models and some argue that Schelling could have acquired his initial ideas at the RAND Corporation where cellular automata models were very popular.[3]

3.1. Interview: Part II

NEA: Could you please tell me how you came up with the checkerboard model of residential segregation? Did your affiliation with RAND have any affect on the formalization of this model?

TCS: I was at RAND in the summer of 1967. I wrote a chapter called "*the process of neighborhood tipping*" (in Antony Pascal's book) at RAND. Probably between the summer of 1967 and summer 1968 I did my checkerboard work. I took it to RAND and asked RAND to computerize it for me.[4] I kept on working on this issue for another year or two. But the checkerboard stuff I did not do at RAND and I did not get the idea at RAND.

I had a strong intuition that you can get a lot of things like fairly extreme segregation through the dynamics of movement. And I was sure that there would be an existing literature on that. So, one summer when I was in RAND—RAND had a pretty good library—I got all of the bound volumes of two or three journals in sociology, believing I would find what I wanted to use in teaching in class about the interactive elements that would lead to unintended patterns. And I could not find anything. I decided, if I am going to teach my students, I'll have to make it all up.

One day I was flying home from Chicago, and I did not have anything to read. I wondered what to do, and decided maybe now was the time to begin playing around with these ideas. So, I drew a line on a sheet of paper, put down sort of a haphazard—not random, but haphazard—x's and 0's, and said now suppose I thought that these were blacks and whites, and both had ideas about neighbors. I started moving them around, even though I had to erase marks to move them, and was extremely clumsy, but by the time my plane landed in Boston I decided this was going to prove interesting. Then I went to work with coins--you do not have to erase them! And then I wanted to do it in two dimensions. In one dimension you can simply move an item and insert it between two others. But in two dimensions you have to have a more specific way of deciding where one can go. That is when I decided, well, I could use the checkerboard and leave blank squares so that the movement could get started. (I thought of hexagons, and decided squares were good enough.)

I intended to use the result in teaching, I though they were interesting. A friend of mine was establishing the Journal of Mathematical Sociology. And he asked me if I would let him publish this in the first issue. That's why it went into that journal.

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[3] For example, Philip Mirowski thinks that Schelling got the idea at RAND (private conversation).

[4] John Casti tried to computerize the model but he was not successful because of the uncertainties in Schelling's model. Schelling did not specify what happens to the agents on the edges, for example. However, we know that Casti (1992) uses a variation of Schelling's checkerboard model in his book 'Reality Rules', when he is talking about cellular automata models.

NEA: Although your model is cited as the predecessor of Cellular Automata (CA) type of modeling in the social sciences, it is also argued that James M. Sakoda was the first person who developed a CA based model in social sciences. Skoda's (1971) "The checkerboard model of social interaction" appeared in the first issue of Journal of Mathematical Sociology with your paper on 'residential segregation'. However, basic ideas of Sakoda's model was already in his unpublished dissertation in 1949. Did you know his work? If you did, were you in anyway influenced by his approach?

TCS: I have never heard of him. Some sociologists worked on social networking, which is a little like the checkerboard interactive models. And there used to be, I think in 1950's, people who had computer games, one was called the game of life. They had rules about who would survive and who would die according to neighbors. And they played around with the various interesting shapes that could occur. But I do not remember that they ever used it to model social phenomena. I think they just used it as abstract configuration formation.

I knew about some examples of Cellular Automata, or whatever you want to call them. But it was not until about five years ago that I discovered that some people thought that I had originated that kind of thing. Peyton Young once started talking to me about this kind of thing, and I said "oh, I have actually published something on that", and gave him my book. He had not been aware of it, but then he saw it, and when he published his book recently he mentioned me as sort of a pioneer, or a predecessor. And I think Josh Epstein talks about me as being a precursor. And I met somebody in Vienna, I do not remember his name, who was doing something like that. And long time ago I discovered, somebody told me that, there were some physical models, I think something in crystal formation. Somebody was referring to ISING model, which was a well-known model of, I think, crystal formation. And it seemed to be reminiscent of what I did, and they were interested in whether if examined in detail the analogy would be preserved at the local detail of the molecules of whatever it was.

4. Concluding Remarks

This short interview contains valuable insights about how Thomas Schelling approaches to modeling and game theory. One of the novelties of Schelling's models and approach is that they suggest a previously unrecognized aggregate mechanism (e.g., a mechanism of residential segregation, or of coordination) by way of explicating the interactions of certain individual mechanisms (e.g., individuals who are trying to avoid a minority status, or to coordinate). Such explanations are appealing because we are familiar with the individual mechanisms and surprising for we did not think about the certain way in which they may interact in bringing about the explanandum phenomenon. It remains to be analyzed how and to what extent Schelling's approach differs from the mainstream approach to modeling in economics.

5. References

Aydinonat, N. E. (2004) *Explaining Unintended Consequences Of Human Action: An Inquiry Into The Role Of Conjectures In Social Science*. Phd. Thesis. Ankara: Imaj Yayıncılık.

Backhouse, R. E., Hausman, D. M., Mäki, U. and Salanti, A. (ed.) (1998) *Economics and Methodology: Crossing Boundaries*, Proceedings of the IEA Conference held in Bergamo, Italy. London: MacMillan.

Binmore, K. G., Kirman, A. and Tani, P. (1993a) "Introduction: Famous Gamesters" in Binmore *et al.* (1993b: 1- 25).

Binmore, K. G., Kirman, A. and Tani, P. (ed.) (1993b) *Frontiers of Game Theory*, Cambridge: The MIT Press.

Casti, J. L. (1992) *Reality Rules: I and II*. New York: Wiley.

Cowen, T. (1998) "Do Economists Use Social Mechanisms To Explain?" In Hedström & Swedberg (1998: 125-146).

Epstein, J. M. and R. Axtell (1996). *Growing Artificial Societies: Social Science from the Bottom Up*. Washington D.C., Brookings Institution Press.

Hedström, P. & Swedberg, R. (Ed.) (1998) *Social Mechanisms: An Analytical Approach To Social Theory*, Cambridge: Cambridge University Press.

Janssen, M. C. W. (1998a) "Individualism and Equilibrium Coordination in Games" in Backhouse et al. (1998).

Lewis, D. (1969) *Convention: A Philosophical Study*, Cambridge: Harvard University Press.

Luce, D. and Raiffa, H. (1985 [1957]) *Games and Decisions: Introduction and Critical Survey*, New York: Dover Publications Inc.

Nozick, R (1974) *Anarchy, State And Utopia*, New York: Basic Books.

Nozick, R (1994) "Invisible-Hand Explanations", *Aea Papers And Proceedings* 84 (2): 314-318.

Pascal, A. H. (1972) *Racial Discrimination in Economic Life*, Lexington: Lexington Books.

Rosser, J. B. JR. (1999) "On The Complexities Of Complex Economic Dynamics", *Journal Of Economic Perspectives*, 13 (4): 169-192.

Rubinstein, A. (1991) "Comments on the Interpretation of Game Theory", *Econometrica* 59(4): 909 – 924.

Sakoda, James M. (1949) *Minidoka: An Analysis Of Changing Patterns Of Social Interaction*, University Of California, Berkeley.

Sakoda, James M. (1971) "The Checkerboard Model Of Social Interaction" *Journal Of Mathematical Sociology*; 1971, 1 (1): 119-132.

Schelling, T. C. (1969) "Models Of Segregation" *American Economic Review*, 59: 488-493.

Schelling, T. C. (1971a) "Dynamic Models Of Segregation" *Journal Of Mathematical Sociology*, 1 (1): 143-86.

Schelling, T. C. (1971b) "On The Ecology Of Micromotives" *The Public Interest*, 25 (Fall): 61-98.

Schelling, T. C. (1972) "The Process Of Residential Segregation: Neighborhood Tipping" In Pascal (1972: 157-185).

Schelling, T. C. (1978) *Micromotives And Macrobehavior*, London & New York: W. W. Norton.

Schelling, T. C. (1984a) "What Is Game Theory?", in Schelling (1984b: 213-42)

Schelling, T. C. (1984b) *Choice and Consequence.* Cambridge, Mass., and London: Harvard University Press.

Sugden, R. (1986) *The Evolution Of Rights, Cooperation And Welfare*, New York: Basil Blackwell.

Sugden, R. (2000) “Credible Worlds: The Status Of Theoretical Models In Economics,” *Journal Of Economic Methodology* 7 (1): 1 – 31.

Swedberg, Richard (1990) *Economics And Sociology: Redefining Their Boundaries: Conversations With Economists And Sociologists***,** Princeton: Princeton University Press.

Ullmann-Margalit, E. (1978) "Invisible Hand Explanations", *Synthese* 39 (20): 263-91.

Young, H. P. (1998) *Individual Strategy And Social Structure: An Evolutionary Theory Of Institutions*, Princeton University Press.