Game Theoretic Models as a Framework for Analysis: The Case of Coordination Conventions

Aydinonat, N. Emrah

Ankara University

1 June 2006

nality: The Adaptive Toolbox,
:quilibrium Selection in Games,
:nt Under Uncertainty: Heuristics
ol. 54, pp. 286-295.
osed Prisoner's Dilemma Game",
ırvard University Press.
ents", *Psychological Review*, Vol.
.: MIT Press.
of Nonselfish Behaviour", *Social*
l. 105, pp. 533-550.
'ol. 16, pp. 175-204.
lie Gold-Ed., *Teamwork: Multi-*
-199.
cit Coordination Games, Strategic
/ol. 80, pp. 234-248.

Aydınonat, N. Emrah (2006) "Game Theoretic Models as a Framework for Analysis: The Case of Coordination Conventions", in Aktan, C. C. (ed.) (2006) *Advances in Economics: Theory and Applications*, Vol. 2, (Selected Proceedings of the Second International Conference on Business, Management and Economics, Organized by Yasar University, 15-18 June 2006, Cesme-Izmir, Turkey) Yasar University: Izmir.

GAME THEORETIC MODELS AS A FRAMEWORK FOR ANALYSIS: THE CASE OF COORDINATION CONVETIONS

N. Emrah Aydınonat
Ankara University, Faculty of Political Science, Turkey
aydinonat@gmail.com

Abstract

This paper examines game theoretic models of coordination conventions. Firstly, the paper shows that static models of coordination cannot explain the emergence of coordination conventions. The best interpretation of these models is that they study the conditions under which coordination is possible. The examination of these conditions suggests that history and existing institutions are important in the process of emergence of institutions. Secondly, an examination of dynamic models of coordination conventions reveals that some of these models explicate some of the ways in which coordination may be brought about in the model world. Nevertheless, consideration of these models fortifies the point that history and existing institutions are crucial for explaining the emergence of conventions in the real world. Based on these observations, the paper suggests that game theory as a framework of analysis is the best possible interpretation of game theoretic models of coordination conventions.

Key words: Game Theory, Coordination, Convention

JEL Classification: ***B41, C70***

1. INTRODUCTION

The present paper focuses on the emergence of coordination conventions and on the use of game theory in this literature. David Lewis' attempt "to render the notion of convention independent of any fact or fiction of convening" (Quine, in Lewis 1969: xii) is a corner stone in the history of explaining the emergence of institutions as unintended consequences of human action. Many attempts had been previously made to show that institutions might be considered as unintended consequences. Lewis combined these ideas, especially those of David Hume and Thomas Schelling, in order to present a convincing argument along these lines. He followed Schelling's (1958: 208) suggestion that "the coordination game probably lies behind the stability of institutions and traditions." His analysis of convention led to a research area known as 'economics of convention'. It is in this area that conventions are usually regarded as solutions to coordination problems.[1] Yet for nontrivial cases, there are multiple solutions to a single coordination problem. While authors such as Schelling and Lewis think that which of the

[1] It is also argued that conventions may emerge out of games that involve partial-conflict. For example, Sugden (1986) lists three types of conventions: (i) coordination conventions, (ii) conventions of property and (iii) of reciprocity (also see Ullmann-Margalit 1977). Under this broader definition, this paper discusses coordination conventions.

two solutions is established as a convention depends on the particularities of the environment, modern (evolutionary) game theory abstracts from these particularities. That is, in contrast to Schelling's and Lewis's ideas, research in this area has been predominantly unempirical. This has been one of the prominent lines of criticism directed at these models. Many authors, such as Sugden (1998ab, 2001), have suggested that the study of convention should be empirical, in the sense that more attention should be paid to the particularities of existent institutions. Here it is argued that the difference of opinions regarding the study of conventions can be resolved by interpreting game-theoretic models of conventions as fulfilling diverse tasks in the process of explaining the emergence of conventions. While some of these models provide partial potential explanations, others examine the conditions under which a certain outcome is plausible. In fact, different models of convention fit each other in a way that allow us to see them as providing a good framework for understanding the emergence of particular conventions and for empirical research concerning conventions.

The plan of the paper is as follows: The second section introduces the idea that conventions are solutions to coordination problems and points out the importance of history and existing institutions in the explanation of the emergence of conventions. The worry that abstract game theoretical analysis may not explain the emergence of conventions is also introduced here. The third section discusses the possibility of coordination in the model worlds created by game theorists. Firstly, standard static games and problems such as 'equilibrium selection' and 'justifying Nash equilibria' are discussed. It is argued that static models cannot explain the emergence of coordination (and hence conventions) even in the model world. The best interpretation of these models is that they study the conditions under which coordination is possible. The examination of these conditions suggests that history and existing institutions are important in the process of emergence of institutions. Secondly, the possibility of coordination in a dynamic setting is discussed; in particular learning and models with boundedly rational agents are discussed. It is argued that learning models explicate some of the ways in which coordination may be brought about in the model world. Nevertheless, consideration of these models fortifies the point that history and existing institutions are crucial for explaining the emergence of conventions in the real world. The fourth section discusses these issues in a general setting and presents a general evaluation of models of coordination and coordination conventions. The fifth section concludes the paper.

2. Coordination Conventions

Let us say that we want to explain the emergence of the 'rules of the road' and to show how such a convention could emerge merely from the interactions of individuals who do not intend to bring it about. Since we want to explain the emergence of the convention we should start from a situation where no such convention exists. If there are no such conventions, when two people approach each other from opposite directions, they have to make a choice. They may drive on the left, or they may drive on the right. It does not matter which side of the road they choose as far as the other person chooses the same side. This is the only thing that matters, because if they fail to coordinate they may

particularities of the
these particularities.
n this area has been
s of criticism directed
ave suggested that the
ention should be paid
that the difference of
y interpreting game-
ocess of explaining the
vide partial potential
n outcome is plausible.
allow us to see them as
particular conventions

troduces the idea that
out the importance of
ce of conventions. The
ain the emergence of
sses the possibility of
y, standard static games
Nash equilibria' are
ergence of coordination
retation of these models
ible. The examination of
important in the process
rdination in a dynamic
dedly rational agents are
of the ways in which
theless, consideration of
titutions are crucial for
fourth section discusses
valuation of models of
cludes the paper.

of the road' and to show
ons of individuals who do
ence of the convention we
sts. If there are no such
ite directions, they have to
e on the right. It does not
person chooses the same
il to coordinate they may

confront hazardous situations. In the terminology of game theory this is a coordination game of the following form:

Table 1. The Driving Game

		Player B	
		Left	Right
Player A	Left	a, a	b, b
	Right	b, b	a, a

$a > 0$ and $b = 0$

Here 'Left' and 'Right' are the possible options for players A and B. The letters, a and b, in the table represent the payoffs to their actions. If both player A and player B choose 'Left' they have positive payoffs. Similarly if they both choose 'Right' they have positive payoffs. If they fail to coordinate they do not have positive payoffs. For simplicity, henceforth, we will assume that $b = 0$. This table tells us that it is in their interest to coordinate. Let us suppose that they have to make their choices simultaneously without any communication. Additionally, assume that individuals A and B are rational, that they both know the rules of the game, and that table 8.1 presents all the information available to them. Given the payoff structure of the game each player has an incentive to predict what the other would do. The question is: "how?"

The driving game is a sample coordination problem[2] and according to Lewis's, if a population of agents expect each other to choose a certain action all the time, we may talk about the existence of a driving convention. More properly,

"A regularity R in the behaviour of members of a population P when they are agents in a recurrent situation S is a convention if and only if it is true that, and it is common knowledge in P that, in any instance of S among members of P,

- everyone conforms to R;
- everyone expects everyone else to conform to R;

[2] There is another game where individuals may unintendedly coordinate their activities, which is called "the minimal social condition." In one version of this game players do not even know that the consequences of their action depend on other players actions, in another version they are not informed about the existence of others. Nevertheless, they know the available strategies and observe the consequences of their actions. The basic idea behind this type of games is that individuals may coordinate their actions even if they do not know the rules and structure of the game. On "the minimal social condition" see Sidowski, Wyckoff and Tabory (1956), Sidowski (1957), Colman (1982a), For a brief overview of the literature see: Colman (1995: 40 - 50).

• everyone prefers to conform to R on condition that the others do, since S is a coordination problem and uniform conformity to R is a coordination equilibrium in S." Lewis (1969: 58)

That is, if in a society everyone drives on the right; expects everyone else to drive on the right; and prefers to drive on the right on condition that the others do, then we may say that the driving convention in this society is driving on the right-hand side of the road. Briefly, in the above game, both (right, right) and (left, left) are candidates for becoming a driving convention. Basically, (right, right) and (left, left) are Nash equilibria of this game,[3] or coordination equilibria in Lewis's terms.[4] An important aspect of this coordination game is that there is no guarantee that the agents will be successful in reaching one of the equilibria (Lewis 1969: 24). In order to explain how conventions emerge one has to show that coordination is possible and how concordant mutual expectations arise.

Now let us consider the case of two players in order to focus our attention on this point. If two drivers are driving in the middle of the road and have no other information than what is available from the above game-theoretic presentation, they will actually have no way to tell rationally what the other will do. In the terminology of game theory, the two equilibrium points (left-left and right-right), which represent the alternative conventions, are formally indistinguishable and the problem facing the players is known as an *equilibrium selection problem*. Yet standard game theory suggests that there is also a mixed strategy equilibrium. In a mixed strategy equilibrium players randomize their choices according to the payoffs attached to the alternatives. Since the payoffs in this game are symmetric, the mixed strategy equilibrium of the game consists of the situation where agents choose one of the two alternatives with equal probability (50%, 50%). However, such an equilibrium could not form the basis of a convention. To see this consider the case for many players: There is no guarantee for success even if all agents mutually expect the others to use a mixed strategy.[5] When everybody uses mixed strategies no one would expect others to conform to a certain pure strategy equilibrium all the time. Agents who continuously use mixed strategies cannot bring about a driving convention.

---

[3] In a Nash equilibrium, the players' strategies are best responses to the other players' strategies, that is, players get the highest payoff given others' strategies (see Gintis 2000: 6-14, Bierman and Ferandez 1998: 16). Or more intuitively, "no player has any incentive to deviate unilaterally from it", so 'players do not regret their strategy choices'. (Colman 1995: 59)

[4] What Lewis calls 'proper coordination equilibrium' is a stronger (solution) concept than the Nash equilibrium. This difference does not change the nature of our argument. Note that Sugden (1998a: 4) argues that "one consequence of Lewis's definition is that he is able to argue that conventions tend to become norms, while on the usual game-theoretic account, Nash equilibria are sustained simply by self-interest."

[5] Moreover, mixed strategy equilibrium is a problematic concept: "it is hard to see how a mixed strategy equilibrium can be a solution" (Bicchieri 1993: 60, also see Fudenberg and Levine 1998: 19).

others do, since S is a
dination equilibrium in S."

veryone else to drive on the
others do, then we may say
right-hand side of the road.
re candidates for becoming
are Nash equilibria of this
important aspect of this
gents will be successful in
o explain how conventions
d how concordant mutual

our attention on this point. If
other information than what
will actually have no way to
of game theory, the two
the alternative conventions,
e players is known as an
uggests that there is also a
m players randomize their
s. Since the payoffs in this
ame consists of the situation
al probability (50%, 50%).
f a convention. To see this
or success even if all agents
hen everybody uses mixed
pure strategy equilibrium all
annot bring about a driving

e other players' strategies, that is,
5-14, Bierman and Ferandez 1998:
y from it", so 'players do not regret

(solution) concept than the Nash
Note that Sugden (1998a: 4) argues
conventions tend to become norms,
imply by self-interest."
hard to see how a mixed strategy
l Levine 1998: 19).

Moreover, it has been suggested that instead of playing mixed strategies agents would search for clues for successful coordination. For example, Schelling (1960) argues that existing conventions, norms, personal history, imagination, analogy, etc. help individuals to single out one of the many equilibria and help them solve novel coordination problems. Lewis expresses the same idea by arguing that salience and precedence are two important means of creating concordant mutual expectations. In the language of game theory, the equilibrium that stands out among others as a salient option is called a '*focal-point* equilibrium'. Schelling (1960) reported a series of informal experiments where real individuals were much more successful in coordination than their model counterparts. Lewis and Schelling's intuition and informal experiments have been confirmed by formal experiments (e.g., Metha *et al.* 1992, 1994ab) that revealed that ("boundedly rational") real individuals were much more successful in solving coordination problems than their (hyper) rational model theoretic counterparts. This suggests that real individuals who are confronted with the driving game base their expectations about others on the particularities of their environment and on history; rather than using mixed strategies.

In general, experiments point out a gap between the "predictions" of standard game theory and the actual behavior of individuals, a gap that has been confirmed by a number of other experiments concerning some other games, such as the ultimatum game (e.g., Güth *et al.* 1982, Henrich *et al.* 2001, 2002).[6] In sum, it is suggested that in these games real individuals were not doing what the theory predicted them to do and that history, cultural and personal traits, experience, analogies with previous situations etc. are relevant for explaining how real individuals behave and how institutions emerge. If this is true then there appears to be an important disparity between the model-worlds created by game theorists and the world where real individuals live.

These experiments support those authors (e.g. Sugden 1998ab, 2001) who demand that explanations of the emergence of institutions should be more empirical. Of course the idea that "institutions and history matter" is neither new nor surprising. Many institutional economists have demonstrated (e.g., North 1990, Greif 1998) that they do.[7] What is surprising may be that many economists and game theorists are convinced that institution

---

[6] Note also that Schelling argues: "[...] the mathematical structure of the payoff function should not be permitted to dominate the analysis." (b) "[...] there is a danger in too much abstractness: we change the character of the game when we drastically alter the amount of contextual detail [...]. *It is often contextual detail that can guide the players* to the discovery of a stable or, at least, mutually non-destructive outcome. [...] This corner of game theory is inherently *dependent on empirical evidence*." Schelling (1958: 252 emphasis added)

[7] The importance of history has been studied widely in different research areas in economics. For example, Tirole (1996) studies what happens if individual's reputation is dependent on his past behaviour and on the behaviour of the group he belongs. He argues that dishonest behaviour in the past increases the time needed to establish a reputation of honesty in a way that a new generation of agents may suffer from the dishonesty of their predecessors. The literature on path-dependency studies how an economy may lock into an inefficient equilibrium because of historical accidents and feedbacks created by externalities (e.g., Arthur 1984, 1985). Other interesting examples are Azariads and Drazen (1990) and Krugman (1991).

free and history independent models, such as the driving game, may provide insights about socio-economic phenomena, despite the existence of intense criticism and evidence on the contrary. If so, many economists are confident that these abstract, ahistorical models have something to contribute, one is tempted to give them the benefit of doubt. It may be that there is some serious misunderstanding between economists who use abstract models and their critics. In order to investigate whether there is such a puzzle, we need to attend to some of the difficulties presented by equilibrium selection and game theory in general.

3. Coordination In the World of Models

The driving game presented in table 1.1 is a one-shot game. It may be considered as a representation of the state of affairs when two individuals face the aforementioned coordination problem for the first time. Moreover, it serves as a representation of the possible outcomes they may reach after making their choices. As we have mentioned, two pure strategy equilibria, (left, left) and (right, right), are considered as states where individuals have no intention to deviate, i.e., change their strategies. Moreover, if many individuals are involved, these equilibrium points *represent alternative conventions*. In order to explain the emergence of conventions, or how individuals coordinate, one has to explain how concordant mutual expectations emerge.

For a certain equilibrium (e.g., left, left) to get established and maintained agents need to "know" what the others will be doing. In other words, every individual should know that every other has a good reason to play a certain strategy (e.g., left) and that this is common knowledge:[8]

"So if a convention, in particular, holds as an item of common knowledge, then to belong to the population in which that convention holds—to be party to it—is to know, in some sense, that it holds. If a regularity R is a convention in population P, then it must be true, and common knowledge in P, that R satisfies the defining conditions for a convention. If it is common knowledge that R satisfies them, then everyone in P has a reason to believe that it is true, and common knowledge in P, that R satisfies them; which is to say that everyone in P must have a reason to believe that R is a convention." (Lewis 1969: 61)

We have argued that given that the Nash equilibria of the driving game are formally indistinguishable from each other it is not possible to explain how individuals would rationally succeed in reaching one of them unless they succeed by chance using mixed strategies. Moreover, the reasoning behind the use of a mixed-strategy does not allow us to argue that if an equilibrium point is reached it may be maintained if the game is repeated. That is, if individuals have no clue about what to expect from the other player and do not update their expectations with the information they have acquired in previous

[8] Something is common knowledge if everyone knows it, if everyone knows that it is known by others, if every one knows that the fact that every one knows that is known by others is known by others, and so on. See Lewis (1969) and Aumann (1976).

may provide insights
:riticism and evidence
e abstract, ahistorical
the benefit of doubt. It
mists who use abstract
h a puzzle, we need to
on and game theory in

nay be considered as a
ce the aforementioned
a representation of the
ve have mentioned, two
idered as states where
ies. Moreover, if many
rnative conventions. In
s coordinate, one has to

aintained agents need to
vidual should know that
and that this is common

owledge, then to belong
it—is to know, in some
n P, then it must be true,
:ions for a convention. If
P has a reason to believe
em; which is to say that
n." (Lewis 1969: 61)

iving game are formally
how individuals would
l by chance using mixed
trategy does not allow us
aintained if the game is
ect from the other player
have acquired in previous

s that it is known by others, if
is known by others, and so on.

plays, we cannot explain how they may expect others to play a certain pure equilibrium strategy. Hence we cannot explain how concordant mutual expectations are established.[9]

The problem of explaining why individuals play a certain equilibrium strategy is based on a deeper problem in game theory: It is commonly argued that Nash equilibrium does not follow from the assumption of rationality of the players, but it is a consequence of the additional assumptions imposed on the players. More generally it is argued that the notion of Nash equilibrium is based on the assumption that players are able to anticipate others' actions (Bernheim 1984).[10]

Aumann argues:

"Nash equilibrium does make sense if one starts by assuming that, for some specified reason, each player knows which strategies the other players are using." Aumann (1987: 2)

Justifying Nash equilibrium, or explaining how it gets established has been an important problem for game theorists that led to the literature known as the *refinements* literature. Although this problem is usually considered as being distinct from that of equilibrium selection, it is closely related.[11] (Harsanyi and Selten 1988, Samuelson 1998) Both

---

[9] However, leaving this problem aside, we may easily see that sometimes it may be useful to use a mixed strategy. For example, if we really do not know what to do, or better, if the outcome of our action is dependent on things we cannot control, we may want to choose one of the alternatives randomly to increase our chances of achieving the "right" result. Considering the above game, we may argue that agents may use a mixed strategy when they have no clue about what to expect from the other player. Thus, the concept of mixed-strategy captures the idea that "clueless" individuals may randomise their choices in the context of a novel coordination problem.

[10] For example, Bernheim argues:

"[...] Nash hypothesis, far from being a consequence of rationality, arises from certain restrictions on agents' expectations which may or may not be plausible, depending on the game being played." Bernheim (1984: 1007)

Concerning the rationality of individuals who are playing their part in the Nash equilibrium Luce and Raiffa argue:

"Even if we are tempted at first to call a [Nash] non-conformist 'irrational', we would have to admit that [his opponent] might be 'irrational' in which case it would be 'rational' for [him] to be 'irrational'—to be a [Nash] non-conformist." Luce and Raiffa (1957: 63) (also quoted in Bernéim 1984: 1009)

Interestingly, this leads them to discuss the nature of game theory:

"We belabour this point because we feel that it is crucial that the social scientist recognise that game theory is not descriptive, but rather (conditionally) normative. It states neither how people do behave nor how they should behave in an absolute sense, but how they should behave if they wish to achieve certain ends. It prescribes for given assumptions courses of action for the attainment of outcomes having certain formal 'optimal' properties. These properties may or may not be deemed pertinent in any given real world conflict of interest. If they are, the theory prescribes the choices which must be made to get that optimum." Luce and Raiffa (1957: 63)

Also see Bicchieri (1993), Crawford (1997: 210), Janssen (1998), Mailath (1992: 259 - 250, 1998: 1351).

[11] Jacobsen (1996: 68) argues that "the problem of justifying Nash equilibrium has nothing in particular to do with multiple equilibria." This is true in that the Nash solution concept is in need of a justification even in the

questions are relevant if we wish to explain the emergence of conventions. In the refinements literature, many suggestions have been made on how to render an equilibrium rational without relying on the assumption of common knowledge. The orthodox justifications[12] (which are based on static games) fail to explain how and why individuals would play certain equilibrium strategies (Colman and Bacharach 1997, Crawford 1997: 210 - 211, Kandori, Mailath and Rob 1993: 29, Janssen 1998a: 12). For example, Aumann and Brandenburger (1995) and Brandenburger (1992) assume that individuals have coordinated expectations,[13] yet, as Janssen (1998a: 9) argues, the justification of the Nash equilibrium in this context requires an explanation of how individuals acquire coordinated expectations. In fact, in order to justify Nash equilibrium in the context of a game one has to make assumptions about agents' expectations or knowledge about others and every such assumption would be in need of further explanation.

Generally, the problem of justifying the Nash equilibrium and explaining why and how agents would choose a salient strategy are similar problems. In order to justify the Nash equilibrium one has to explain, in a sensible manner, why agent I would expect agent II to choose the Nash strategy, and expect agent II to expect himself (agent I) to expect agent II to play the Nash strategy and so on. In order to explain why a salient strategy is chosen one has to explain why agent I would expect agent II to choose the salient strategy, and expect agent II to expect himself (agent I) to expect agent II to play the salient strategy and so on. For example, if two game theorists play a game with a unique Nash equilibrium, they would consider the Nash equilibrium as a salient option because they would mutually expect the other to play his part in the Nash solution, given that they know that their co-player is a game theorist as well.[14] This is because, "the salience of any particular mode of behaviour depends critically upon whether that salience is universally

---

absence of multiple-equilibria. However, the solution of the problem of equilibrium selection necessitates a justification of the Nash equilibrium.

[12] While orthodox justifications are keep the standard structure of the game, non-orthodox justifications do not (see Janssen 1998a). Some of the orthodox justifications of Nash equilibrium are as follows: correlated equilibrium (Aumann 1987, also see Janssen 1998a and Sugden 1991 for a criticism), coordinated expectations (Aumann and Brandenburger 1995, Brandenburger 1992). Other well known refinements of the Nash equilibrium concept are subgame-perfect-equilibrium (Selten 1975), trembling hand (Selten 1975) intuitive criteron (Cho and Kreps 1987).

[13] According to Aumann (1987: 1) the puzzle is the following: "why and under what conditions the players in an n-person game might be expected to play such an equilibrium," in an n-player game. Particularly he asks: 'why should we expect players to play their part in the equilibrium?' To expect players to play their part for an unique equilibrium, player I has to expect the player II to play his part, and player II would play his part if and only if he expects player I to play his part. Correspondingly, Aumann introduces the notion of 'correlated equilibrium'. In the correlated equilibrium players do not (need to) know what others are doing. Yet it is assumed to be common knowledge among players that players maximize their expected utility given their information.

[14] "In the language of Schelling, Nash equilibrium may be 'focal'. If agents share the common belief that Nash equilibrium is normally realised, they no longer entertain the rationally admissible doubt that an opponent will fail to conform." Berneim (1984: 1009)

of conventions. In the
to render an equilibrium
wledge. The orthodox
ow and why individuals
h 1997, Crawford 1997:
98a: 12). For example,
assume that individuals
s, the justification of the
now individuals acquire
orium in the context of a
knowledge about others
on.

explaining why and how
order to justify the Nash
would expect agent II to
(agent I) to expect agent
salient strategy is chosen
the salient strategy, and
play the salient strategy
ne with a unique Nash
ient option because they
solution, given that they
ause, "the salience of any
at salience is universally

ibrium selection necessitates a

non-orthodox justifications do
ium are as follows: correlated
for a criticism), coordinated
well known refinements of the
trembling hand (Selten 1975)

what conditions the players in
yer game. Particularly he asks:
ct players to play their part for
player II would play his part if
oduces the notion of 'correlated
hat others are doing. Yet it is
eir expected utility given their

share the common belief that
ally admissible doubt that an

recognised" (Berneim 1984: 1010). Yet if two individuals who do not have knowledge of game theory play the same game we would have no good reason to believe that they would play their Nash strategies. Neither the emergence of the Nash outcome nor the selection of a salient equilibrium among multiple equilibria can be explained without explaining how agents *come to believe* that the others will behave in a particular way. A satisfactory explanation of how a certain Nash equilibrium gets established seems to require a model of learning or of how agents form and update their expectations. Particularly, one has to explain why agents would consider a certain equilibrium as being focal or salient.

3.1.Focal Points

Schelling's (1960) focal point argument and Lewis's concept of salience has been interpreted by game theorists in different ways. Game theorists have tried to integrate the idea that individuals maybe successful in coordination games if a certain strategy stands out as an obvious option into the formal structure of the game. Two well-known standard examples of this approach are the arguments from Pareto dominance and risk dominance. It has been argued that if one of the Nash equilibria Pareto dominates others then one may argue that agents might use this as a coordination device (Harsanyi and Selten 1988).[15] That is, Pareto dominant equilibrium may be considered as a focal-point equilibrium. Yet in some games Pareto dominant equilibrium is not always an obvious solution. For example, in the stag-hunt game agents may perceive the Pareto dominant equilibrium as a risky option and try to play their parts for the risk dominant equilibrium (Carlsson and van Damme 1993ab[16], cf. Harsanyi and Selten 1988). Nevertheless, unless agents are assumed to know how the other player thinks, neither Pareto dominance nor risk dominance seems to be a compelling argument for equilibrium selection.[17]

Another line of research in the line of justifying or rationalizing focal points focuses on the attributes of the different alternatives that are present in the game setup.[18] For example, suppose that you are a participant of a select-a-ball experiment. You and your co-player are located in different rooms and you are asked to choose one ball among three balls. Two of the balls are red, one is green and the red balls are indistinguishable. If you

[15] For example, Young's (1998) model of the emergence of the medium of exchange "predicts" that the Pareto-dominant equilibrium will be selected. Also see the section on learning, below.

[16] This relates to another refinement known as the 'global games approach'.

[17] However, it should be noted that evolutionary game theory is argued to provide a firmer basis for risk dominance (e.g., Kandori, Mailath and Rob 1993, Young 1998) and recent theories of focal points follow the idea that Pareto dominant equilibrium will be selected (e.g., Bacharach and Bernasconi 1997, Janssen 1995, 1998a, 2001, also see below).

[18] For a good overview of 'focal points' see Janssen (1998b). For an early attempt to formalize the focal points see Gauthier (1975). Some of the recent work on focal points can be listed as follows: Bacharach (1993, 1994), Bacharach and Bernasconi (1997), Bacharach and Stahl (1997), Binmore and Samuelson (2002), Casajus (2001), Crawford and Haller (1990), Goyal and Janssen (1996), Janssen (2001ab), Metha et al. (1992, 1994ab), Stahl (1993).

are able to coordinate on the same ball you will get 50 Euros, if not you get nothing.[19] It is argued that since individuals cannot discriminate between the red balls (*principle of insufficient reason*) they should choose the green ball (see Bacharach 1991 and Janssen 1995, 1998a: 15, 2001). This approach tells us that individuals may rationally play their part in a focal-point equilibrium given that there is a unique strategy which is Pareto optimal and that the individuals are able to cluster the indistinguishable alternatives together (*principle of coordination*).[20]

There were some attempts to study the importance of labeling and framing in coordination games. Sugden (1995) distinguishes between the strategic structure of the game and the way in which the game is described or labeled for players. The result is that the particular way in which the game is described (or perceived) influences the outcome of a coordination game. Yet he assumes that the labeling procedure is common knowledge among the agents and it remains to be explained how the labeling procedure becomes common knowledge.[21] Bacharach and Bernasconi (1997), on the other hand, try to formalize the different ways in which strategies may be framed. They generalize Bacharach (1991)'s idea that players' options are acts under descriptions and they are distinguished by the concepts the players use to specify them. This model permits to conceptualise the possible differences in agents' perceptions and for this reason it is a step further in understanding how these differences may influence the outcome of a coordination game. Like Janssen (2001b), this model focuses on the attributes of the alternative strategies and how players of the game perceive these attributes. Yet unfortunately, the model is only able to "predict" the outcome of simple coordination games.

---

[19] The experimenters marked the red balls in a way that cannot be seen, for example, by placing pieces of papers marked with different numbers in the balls. After the selection is made the balls are opened to see whether coordination has been achieved.

[20] This approach is based on two principles. PIR (principle of insufficient reason): one cannot rationally discriminate two strategies if they have the same attributes. POC (principle of coordination): "if in a class of strategy combinations that respect PIR there is a unique strategy combination that is Pareto-optimal then individual players should do their part of that strategy combination" (Gauthier 1975, Janssen 1998: 15). If if p(i)(j) is the probability that player i chooses strategy j then p(1)(red) + p(1)(red) + p(1)(green) = 1. That is, 2p(1)(red) + p(1)(green) = 1. Similarly, 2p(2)(red) + p(2)(green) = 1. The class of mixed strategy combinations that respect PIR are {(p(1)(red), p(1)(red), p(1)(green)), ((p(2)(red), p(2)(red), p(2)(green))}. According to PIR the Pareto optimal strategy combination is: {(0, 0, 1), (0, 0, 1)}. This means that individuals should choose the green object according to POC (Janssen 1995, 1998). (Note the similarity between POC and payoff-dominance (or Pareto-dominance) of Harsanyi and Selten (1988)).

[21] Indeed, Sugden (1995) is conscious of the incompleteness of his attempt. He follows Schelling in that salience is an empirical matter and no theory of focal points can be complete. In another place he argues:
"they [game theorists] have been unable to integrate salience into the formal structure of game theory. [...] few game theorists have been interested in investigating the facts of salience. [...] Instead, they have continually been puzzled by their inability to fit salience into a theoretical structure based on a priori deduction from premises about rationality." (Sugden 2001: F220)

if not you get nothing.[19] It is
the red balls (*principle of*
Bacharach 1991 and Janssen
als may rationally play their
que strategy which is Pareto
ndistinguishable alternatives

f labeling and framing in
the strategic structure of the
for players. The result is that
ived) influences the outcome
eling procedure is common
d how the labeling procedure
(1997), on the other hand, try
be framed. They generalize
der descriptions and they are
them. This model permits to
ns and for this reason it is a
influence the outcome of a
uses on the attributes of the
erceive these attributes. Yet
tcome of simple coordination

n, for example, by placing pieces of
is made the balls are opened to see

icient reason): one cannot rationally
iple of coordination): "if in a class of
nbination that is Pareto-optimal then
authier 1975, Janssen 1998: 15). If if
p(1)(red) + p(1)(green) = 1. That is,
= 1. The class of mixed strategy
((p(2)(red), p(2)(red), p(2)(green))}.
(0, 0, 1)}. This means that individuals
3). (Note the similarity between POC
988)).
attempt. He follows Schelling in that
plete. In another place he argues:
formal structure of game theory. [...]
of salience. [...] Instead, they have
eoretical structure based on a priori

Formal models of focal points commonly focus on whether one may explain the selection of the focal-point equilibrium without assuming common knowledge, or common history. In these models, the modeler predetermines the salient or focal option. For example, in the select-a-ball game a "focal" alternative, green, was embedded in the game setup. What remains to be explicated in this context is the conditions under which rational individuals would choose the focal alternative. These conditions are expressed as principles, such as the principles of insufficient reason, coordination, rarity preference etc. Although formal approaches to focal points justify the intuitive idea that rational individuals would choose the green object (the odd one) in the three ball version of the select-a-ball game, they do not help us solve the equilibrium selection problem presented by games with two Pareto non-comparable Nash equilibria; such as the driving game in table 1.1.

Consider a version of the select-a-ball game where there are only two balls: one red and one green. In this game, there is no unique strategy that is Pareto optimal. For this reason, the alternative strategies remain formally indistinguishable from the point of view of the models examined above. Yet remember Schelling's argument that real individuals are more successful in coordination than the model theoretic agents in games. Then, according to him, connotations of green and red, as well as culture, history and experience of the players might influence the way in which this coordination problem would be solved in the real world. For example, given the existing conventions concerning the colors on warning tags and traffic symbols, if both agents think that the color "red" is more prominent than "green" and expect the other to do the same they might be able to coordinate by selecting the red ball.[22] That is, the existing conventions might influence the way individuals play this game. (A similar may be developed for for Bacharach and Bernasconi's model).

In sum, static models (discussed above) *study the conditions under which coordination may be possible*, rather than focusing on the mechanisms of coordination. Standard game theory, refinements and models of focal points introduce the conditions under which a certain equilibrium is plausible, but the emergence of conventions remains unexplained.[23] We learn from these models that successful coordination is a plausible outcome of a coordination game if conditions such as 'common knowledge', 'correlated expectations', or 'shared frames' hold. Successful coordination is compatible with rationality only under these conditions. If we believe that individuals have a tendency to behave rationally ceteris paribus we should take these results seriously. This framework implies that explaining the emergence of a particular convention requires the introduction of further

[22] In fact, Metha et. al's (1994b) experiments confirm a similar result.

[23] For example, Mailath argues:
"The refinements literature still serves the useful role of providing a language to describe properties of different equilibria. Applied researchers find the refinements literature of value for this reason, even though they cannot depend on it mechanically to eliminate 'uninteresting' equilibria." Mailath (1998: 1372)

factors (e.g., existing conventions, history etc.) because the structure of the game does not necessarily tell us how such an equilibrium may be reached. Bernheim makes a similar point:

"The economist's predilection for equilibria frequently arises from the belief that some underlying dynamic process (often suppressed in formal models) moves a system to a point from which it moves no further. However, where there are no equilibrating forces, equilibrium in this sense is not a relevant concept. Since each strategic choice is resolved for all time at a specific point during the play of a game, the game itself provides no dynamic for equilibration." Bernheim (1984: 1008)[24]

As a model of conventions the driving game in table 1.1 does not explain how conventions may emerge, but merely provides a framework for analyzing some of the properties of conventions. The explanation of the emergence of convention appears to require that we bring in more ingredients to this model and consider the process of emergence of conventions. The next section discusses whether 'learning' may explain the possibility of coordination.[25]

3.2.Rationality and Learning

The driving game presented in table 1.1 is a one-shot game. It may be considered as a representation of the state of affairs when two ("clueless") individuals face the aforementioned coordination problem for the first time. A two-player one-shot game cannot be a good model of the emergence of driving conventions. At most it describes the relevant coordination problem for two individuals, but not how it is solved. Coordination of two drivers is not enough to create a convention: for a convention to exist there should be many drivers who are coordinating on one of the equilibrium points and who are expecting the others to do the same. Hence the relevant game theoretic concept here would be a multi-player repeated game; e.g., where *n* individuals repeatedly meet in pairs and play the one-shot driving game in table 8.1 (which is called the 'stage game' in this context). However, even if we present the game in this form standard (non-evolutionary) game theory is not very helpful in explaining the emergence of conventions, or in showing how one of the two possible equilibrium points is reached. The perfectly rational

[24] Bernheim (1984) and Priĉe (1984) suggest an alternative concept of rationalizability:
"[...] an individual is rational [...] if he optimises subject to some probabilistic assessment of uncertain events, where his assessment is consistent with all of his information. [...] If it is possible to justify th choice of a particular strategy by constructing infinite sequences of self-justifying conjectured assessments in this way, then I call the strategy 'rationalizable'." Berneim (1984: 1011)
However, rationalizability cannot easily be considered as a refinement or a justification of Nash equilibrium concept. Because, it is less strict than the Nash equlibrium concept. For example, Samuelson (1998) considers the concept of rationalizable strategy as being somewhat opposite to the refinements movement. Rationalizability criterion helps us justify players' choices, but it does not help us discriminate among several equilibria of the game (Bicchieri 1993: 51 - 52).

[25] Another mechanism that may explain successful coordination is replicator dynamics.

ture of the game does not
ernheim makes a similar

rom the belief that some
els) moves a system to a
e no equilibrating forces,
rategic choice is resolved
game itself provides no

l does not explain how
or analyzing some of the
of convention appears to
l consider the process of
'learning' may explain the

It may be considered as a
s") individuals face the
wo-player one-shot game
ns. At most it describes the
it is solved. Coordination
ention to exist there should
rium points and who are
me theoretic concept here
ls repeatedly meet in pairs
ed the 'stage game' in this
tandard (non-evolutionary)
nce of conventions, or in
hed. The perfectly rational

alizability:
abilistic assessment of uncertain
f it is possible to justify th choice
g conjectured assessments in this

justification of Nash equilibrium
mple, Samuelson (1998) considers
to the refinements movement.
elp us discriminate among several

r dynamics.

model-players who are able to reason about all possibilities in the repeated game would fail to bring about a convention for they would have no clue about what exactly to expect from others given the structure of the game (also see Bernheim 1984: 1008 – 1009). Obviously, random play (e.g., playing a mixed strategy) of all agents would not bring about a convention. Moreover, even if all (or most of the) agents would be able to coordinate on one of the equilibria by chance, this equilibrium would not be stable and would not constitute a convention. That is, unless agents update their expectations or learn to play in a certain way as they repeatedly play the game we cannot explain how a certain equilibrium point would be self-supporting.

Given the concepts of salience, precedence and focal points, explanation of individuals' success in coordination and emergence of conventions necessitates the study of learning in coordination games. The mechanisms of imitation, reinforcement and best reply dynamics have been employed in various forms to study the consequences of individual learning behavior in coordination games.[26] There is a large number of models that use different assumptions concerning how individuals learn in repeated games. It is not necessary to give a full account of this literature here.[27] It will suffice to examine some of the important ideas in order to give a flavor of the models that focus on learning and evolution in the context of a coordination problem.

Standard justifications of the Nash solution concept and solutions to the equilibrium selection problem fail to explicate why rational individuals would play their part in the Nash equilibrium or choose a certain Nash equilibrium among many. Assuming 'common knowledge', 'correlated expectations' or 'shared frames' does not help us explain how real world agents are able to coordinate, and individual dynamics of coordination has to be examined to explain the emergence of conventions as unintended consequences of human action. An important question is whether rational individuals who learn from experience might arrive at a coordination equilibrium. Or whether we could explain the emergence of a convention without restricting individuals' expectations and learning behaviour with a certain form of common knowledge assumption. Goyal and Janssen (1996), who study similar questions, argue that rationality alone does not suffice to explain coordination even if individuals are able to learn. The idea behind this argument is the following: In order to ensure coordination in the next period, every agent has to take into account the previous plays of other players. However, since every player knows that the other players are using the information gathered in previous plays to form their expectations for the next period, in order to ensure coordination every player has to know how the others are forming their expectations. The problem is that the outcome of the previous encounters does not restrict the type of hypotheses they might entertain about

[26] For an extended discussion on learning in game theory see: Fudenberg and Levine (1998), Marimon (1997), Milgrom and Roberts (1991).

[27] For an example of a model with imitation see Luo (1999), for artificially intelligent learning see Marimon et al. (1990), for Bayesian learning see Schotter (1981) and for fictitious play see Young (1998).

each other. In other words, as Goyal and Janssen argue, at any point in time one may entertain an infinite number of hypotheses about others, which are consistent with their information. Thus, unless the modeler restricts the number of these hypotheses, rationality does not ensure that players learn how to coordinate.

Crawford and Haller (1990) and Kalai and Lehrer (1993ab), on the other hand, argue that rational individuals can learn to coordinate. While Crawford and Haller assume that there are optimal rules for learning, Kalai and Lehrer put certain restrictions on individuals prior beliefs. Yet these assumptions (restrictions) imply that rationality alone cannot ensure coordination. More specifically, Goyal and Janssen (1996) argue that even if there may be optimal rules for learning how to coordinate, these rules are not unique. That is, if agents' learning behaviour is not coordinated at the outset they might not be able to coordinate. Similarly, Kalai and Lehrer's model indicate that agents' prior beliefs have to be coordinated to ensure their success in coordination. Both models imply that pre-existent conventions are necessary for individuals' success in coordination. Goyal and Janssen's argument is consistent with our interpretation of the literature on refinements and focal points: In the model world, *coordination is only possible (i.e. individuals might be able to learn to coordinate) if conditions such as common knowledge, shared background, or correlated expectations hold.* Again, from the perspective of explaining real world coordination problems, this means that the knowledge of pre-existing conventions is necessary to explain how coordination is achieved.

Note that Goyal and Janssen's argument supports Lewis, Schelling and others who argue that explanation of the emergence of conventions is an empirical matter. Yet one may still argue that models of learning point at certain dynamics in the explanation of successful coordination. Schotter's model (1981) shows that under some conditions simple learning might bring about conventions. Crawford and Haller's model indicates that if we can ensure that individuals are using a certain type of learning behaviour they may be able to coordinate. Kalai and Lehrer's model can be interpreted as saying that agents drawn from a population with shared conventions may learn to coordinate and bring about conventions. That is, a learning mechanism may bring about conventions under certain conditions. Of course, this alone does not explain the emergence of any particular convention. These models suggest certain possibilities.

Nevertheless, many argue that rationality is not a good criterion either. It is argued that if we want to understand how real individuals achieve coordination we should consider more realistic models of real individuals (e.g., Marimon 1997: 278 – 282, Young 1998). Let us return back to the driving game in order to recall the results of models with bounded rationality.

3.3. Bounded r

Young's (1998)
a dynamic know
model of what t
did in the past.
others have cho
distribution for
of this process is
right). Both of t
individuals reach
state of affairs w
the outcome of t
results apply if
when driving on t

The above mode
conventions emer
into this model b
the "mistakes" of
the one indicated
player chooses hi
she chooses anot
there are shocks
equilibria than in
equilibrium.[30] Th
model.[31] Becaus
probability that t
conventions em
occasionally sw
equally desirabl
However, if one
of its time in the
model mistakes
where the Pareto

[28] Fictitious play ha
1951, also see You
(1995, 1998) and Kr
[29] Note that in this c
[30] For learning and
Fudenberg and Harr
[31] Note that in Kan
Young (1990) it is i

y point in time one may
are consistent with their
er of these hypotheses,

the other hand, argue that
d Haller assume that there
estrictions on individuals
rationality alone cannot
6) argue that even if there
s are not unique. That is, if
hey might not be able to
gents' prior beliefs have to
h models imply that pre-
n coordination. Goyal and
e literature on refinements
sible (i.e. individuals might
mmon knowledge, shared
e perspective of explaining
nowledge of pre-existing
ed.

lling and others who argue
al matter. Yet one may still
e explanation of successful
conditions simple learning
el indicates that if we can
aviour they may be able to
ing that agents drawn from
ordinate and bring about
conventions under certain
ergence of any particular

on either. It is argued that if
nation we should consider
: 278 – 282, Young 1998).
the results of models with

3.3. Bounded rationality and learning

Young's (1998) model of emergence of money presumes bounded rationality. It involves a dynamic known as *fictitious play*[28] in which each player constructs a simple statistical model of what the other people are doing based on fragmentary information on what they did in the past. The idea is roughly as follows: Each player observes the actions that the others have chosen up to a given time t. Then player i computes the observed frequency distribution for his sample size and chooses a best reply to this distribution. The outcome of this process is that after some time individuals coordinate on either (left, left) or (right, right). Both of these equilibrium pairs may be considered as conventions because when individuals reach a state where every one chooses the same strategy their best reply to this state of affairs would be to continue playing the same strategy. The model also says that the outcome of this process depends on its initial states, i.e., it is non-ergodic. Similar results apply if one of the equilibrium pairs Pareto-dominates the other; for example, when driving on the right yields a higher payoff than driving on the left.[29]

The above model says that it is possible in this setup that one of the alternative conventions emerges. Yet real individuals make mistakes and this may be incorporated into this model by introducing small persistent stochastic shocks. These shocks represent the "mistakes" of the players and/or other reasons they may choose an action other than the one indicated by the history of play. In our case we may simply assume that every player chooses his best reply strategy with a high probability 1 - ε and with probability ε she chooses another strategy (Young 1998). Foster and Young (1990) argue that when there are shocks of this sort the dynamic system spends most of its time in certain (Nash) equilibria than in others. They have called such an equilibrium a *stochastically stable equilibrium*.[30] The introduction of persistent stochastic shocks changes the results of the model.[31] Because of the mistakes (or mutations, if you wish) now there is a positive probability that the system might move from one Nash equilibrium to the other. That is, conventions emerge but they do not stay forever. In the long run, the "society" occasionally switches between alternative conventions. When both conventions are equally desirable, the model cannot tell which of the two conventions will emerge. However, if one of the conventions is better than the other, then the system spends most of its time in the Pareto-optimal equilibrium (which is also risk dominant). That is, in this model mistakes ensure that the better convention is followed most of the time. In cases where the Pareto-optimal equilibrium is not also the risk dominant equilibrium (as in the

---

[28] Fictitious play has been first employed as a tool to compute Nash equilibria (see Brown 1951, Robinson 1951, also see Young 1998: 31). For an extensive discussion of fictitious play see Fudenberg and Levine (1995, 1998) and Krishna and Sjostrom (1995)

[29] Note that in this case Pareto-dominant equilibrium is also the risk-dominant equilibrium.

[30] For learning and stochastic dynamics see Foster and Young (1990), Kaniovski and Young (1995), Fudenberg and Harris (1992), Kandori, Mailath and Rob (1993), Kandori and Rob (1995).

[31] Note that in Kandori, Mailath and Rob (1993) randomness is at the individual level while in Foster and Young (1990) it is introduced at the aggregate level.

stag-hunt game), risk dominant equilibrium is the stochastically stable outcome (Foster and Young 1990, Kandori, Mailath and Rob 1993, Young 1993). Hence, the model solves the equilibrium selection problem and the risk dominant equilibrium gets selected.

Ellison (1993) points out an important issue concerning these models. It is argued that the model converges to the risk-dominant equilibrium in the long run. Yet how long is the long run? If we assume for a moment that the assumptions of the model hold for a particular society in the real world, could we expect to observe the emergence of a convention in a reasonable period of time? Ellison examines the nature of convergence and argues that if individuals interact locally (i.e., if individuals mostly interact with their neighbors) then the dynamics introduced by the above model may be plausible for large populations.[32] In brief, the final result of these models is that boundedly rational agents who interact locally might bring about conventions.[33]

Yet it seems to be somewhat puzzling that while rational individuals could not learn to coordinate, myopic individuals can. In fact, bounded rationality assumption is a way of constraining individual behavior. When individuals are myopic and base their decisions on fragmentary information one may dispense with the common knowledge assumption in a dynamic setting. Yet even if individuals are not fully rational they need to form expectations about others. Indeed they are implicitly assumed to expect others to continue doing what they did in the past. Moreover, they are assumed to form their expectations in a certain manner; e.g., by constructing a simple statistical model of what the other people are doing based on fragmentary information. When considered from the perspective of the real world these assumptions are in need of further explanation. One has to justify in one way or the other that this is a plausible assumption about individual behavior. Briefly, while these models dispense with the common knowledge assumption they constrain individual behavior in another way. It should also be noted that there is no guarantee that real individuals would conceive the problem situation as described in the model. They may consider alternative strategies or entertain different hypothesis about other individuals' future behavior. Thus, assuming bounded rationality does not help us avoid the questions concerning existing institutions and conventions. Or in other words, assumptions concerning learning behavior are problematic in a similar manner to assumptions concerning common knowledge. In the latter one has to explain how common knowledge (or common priors, correlated expectations) is acquired, in the former one has to explain why individuals form their expectations in that particular

---

[32] In fact, Kandori, Mailath and Rob (1993) argue that their results are more applicable to small populations than large populations. Ellison (1993) argues that the rate of convergence decreases as the number of players increase. Yet local interaction allows that the results hold for large populations. Similarly, Young (1998) argues that in large populations the process may stick to an inferior state, but in small groups it is more likely that optimum "technology" is selected. An example of this may be the QWERTY case, where a large population of individuals stick to an inferior technology. (Arthur 1984, 1985)

[33] See Young (1996, 2001) for a model of local interaction and Goyal and Janssen (1997) for a discussion of coexistence of conventions.

manner. Yet a single model cannot explain everything at the same time. Learning models study how concordant mutual expectations may emerge and for this reason they fare better than static models with respect to explicating the mechanisms that may bring about conventions.

One may also ask whether the agents in these models learn anything at all. For example, Fudenberg and Levine (1998: 143) argue that agents in these models have information about the current state and this is the only thing they care about. Every time they respond to this information, yet they do not learn anything about others at all. Fudenberg and Levine suggest that the assumptions concerning the agents' learning behaviour can be viewed as an approximation to a model where individuals are less perfectly informed. More properly these models ask what would happen if individuals respond to fragmentary information concerning the history of play. Note that these models define an individual mechanism that may be called a *best reply mechanism*, or a *fictitious play mechanism*, and show that their interaction may bring about conventions. The interaction of the individual level mechanisms forms an aggregate level mechanism that may be called the mechanisms of the *accumulation of the precedent*. Thus, these models explicate how 'precedent' may help individuals solve coordination problems. Although precedents may accumulate in different ways in the real world, these models suggest a particular way in which they may relate to individual mechanisms.

4. Interpretation

This section discusses various implications of our discussion of game-theoretic models of coordination and convention. It should be noted here that game theory poses many difficult philosophical and methodological questions. Especially concepts such as 'rationality' and 'utility' are prone to deep philosophical criticism. This section merely aims at discussing the nature of the explanations provided by models of coordination and convention. The philosophical discussion of 'rationality' and 'utility' are beyond the limits of this paper.

4.1. End-state models

In the previous section we have examined the possibility of coordination in the model world. We have learned that coordination is possible in the model world but only under specific assumptions concerning common knowledge and rationality. The necessity of such assumptions may be interpreted in two ways. On one hand, one may argue that game theory cannot explain how a certain Nash equilibrium emerges out of a coordination game and hence dismiss such models. On the other hand, one may argue that the necessity of these assumptions implies something about the real world: Rationality alone is not sufficient for successful coordination; other conditions need to be satisfied. The former interpretation is based on a correct observation. It is true that these models do not explain how successful coordination emerges. Yet it does not follow from this that these models should be dismissed. It is not the task of these models to explain how and why coordination and conventions emerge. Rather, static models of coordination are partial models; they do not take into account every relevant aspect of coordination. They study whether successful coordination is consistent with rationality and if so, under what conditions. Thus they should not be considered as ready explanations of particular real world cases. This would be expecting more than these models could offer. They tell us what is possible under what conditions and suggest further lines of research for the development of general models of coordination and emergence of conventions. They bring forth the idea that rationality alone is not sufficient for successful coordination and that other conditions have to be satisfied.34 Then, it is argued here that static games should be considered as partial models that test the plausibility of certain hypothesis in the abstract. They should not be expected to provide an explanation of why and how successful coordination and conventions emerge. These models are end-state models and their role should not be overestimated.[35]

4.2.Process models

The models that study the process of emergence of coordination and conventions (e.g., Young 1998) are more concerned with explicating the mechanisms that may bring about coordination and conventions. These models capture certain tendencies concerning individual behavior in isolation: For example, we know that some people imitate others, or individuals take their decisions based on fragmentary information concerning their environment. These models study these "known" tendencies in isolation from other factors to see whether these tendencies, or individual mechanisms bring about coordination in the world of models. They demonstrate that the interaction of such individual mechanisms may bring about coordination and conventions, and that it might be possible in the real world that such mechanisms may be working behind the development of conventions. Nevertheless, they provide partial potential theoretical explanations. They do not provide ready-made explanations for particular cases; rather they alert us to the idea that mechanisms, such as learning and imitation, may be used to explain particular cases.

4.3.Conventions as Unintended Consequences

These models study whether conventions could be unintended consequences of human action and argue that they might be. This does not amount to holding that this is the only way conventions may arise. Researchers in this particular field are in fact commonly conscious of the fact that conventions may also be brought about intentionally. Lewis notes three means of producing concordant mutual expectations: (i) agreement, (ii)

---

[34] It can be argued that rationality is not a necessary condition either. However, note that end-state models generally rest on the rationality assumption.

[35] The concept of evolutionarily stable strategies may be considered as relating to the stability and persistence of certain equilibria. In the context of explanation of conventions static evolutionary analysis examine the conditions under which a certain convention is stable and persistent in the model world. Although, ESS is a static concept it rests on an idea of evolutionary dynamics and the mechanisms behind evolutionarily stable equilibria has been studied with dynamic models.

nations of particular real
could offer. They tell us
ines of research for the
ce of conventions. They
ccessful coordination and
d here that static games
of certain hypothesis in
anation of why and how
are end-state models and

on and conventions (e.g.,
sms that may bring about
n tendencies concerning
me people imitate others,
rmation concerning their
in isolation from other
nechanisms bring about
t the interaction of such
entions, and that it might
be working behind the
rtial potential theoretical
or particular cases; rather
imitation, may be used to

l consequences of human
olding that this is the only
ld are in fact commonly
bout intentionally. Lewis
tions: (i) agreement, (ii)

ver, note that end-state models

g to the stability and persistence
lutionary analysis examine the
odel world. Although, ESS is a
ms behind evolutionarily stable

salience, and (iii) precedence.[36] Neither Lewis nor other game theorists deny that conventions may be brought about by agreement and that they might be intended. Nevertheless, they put this possibility aside and examine whether they may also be brought about as unintended consequence. For example, Young argues:

"We have shown how aggregate patterns of behaviour at the societal level can emerge from many decentralized decisions at the individual level. Of course, it would be absurd to claim that this is the only way in which such patterns arise." Young (2001: 150 -151)

These remarks are well in line with our interpretation that these models are partial. Partiality of these models suggest that the explanation of particular cases *might* require taking into account the mechanisms of learning, imitation etc. and explicit agreement together. Although these models rule out the possibility that conventions might be partially or fully intended, this does not imply that conventions cannot be intended. Rather they suggest that the mechanism they postulate might be playing an important role in the process of the emergence of conventions. In particular cases, one or more of the postulated mechanisms may be working separately or in combination. Moreover, the suggested mechanisms (e.g., learning) might be important even though a particular convention has been imposed by agreement.

4.4. Necessity of Empirical Research

It has been suggested throughout the paper that existing institutions and history are relevant if we want to explain the emergence of particular conventions. The same idea can also be expressed in a more general way: These models provide an abstract understanding of coordination and convention. Such an understanding concerns only a small part of the real world in isolation from all other (possibly relevant) influences. Since these models examine few aspects of coordination (as it occurs in the real world), other models focusing on other aspects of the real world as well as empirical research are needed in order to get a better understanding of how individuals coordinate their activities and how conventions emerge.

Remember that in the beginning of this paper we have noted an important criticism concerning game-theoretic models of conventions. These models are criticized because they are ahistorical and too abstract. It is not suggested here that this criticism is without foundation; rather it is argued here that this criticism should be re-evaluated. It is one of the arguments of this paper that explanation of particular cases necessitates empirical research-- i.e., empirical research is needed for explaining particular cases. One has to bring in the relevant historical factors and the peculiarities of the specific environment

[36] If concordant mutual expectations are created by agreement then the convention is intentionally created. That is, if agents recognise the problem and agree on a solution (e.g., driving on the right) then they are explicitly intending to bring about a consequence at the social level. If agents solve the problem through salience or precedence then the emerging convention may be considered as an unintended consequence of their actions given that they do not intend to bring about the convention.

under study in order to explain why one particular convention rather than another is established at a particular place and time. Yet this does not imply that general models of coordination and convention should be given up. These general models portray the possible outcomes of individual interaction and explicate the ways in which they might be brought about in the real world. They are useful for empirical research exactly for this reason. Note that the formal framework of game theory allows scientists to study individual behavior in specific settings and to learn more about individual behavior. From this perspective, although standard game theory cannot explain the mechanisms that bring about coordination, it played (and still plays) an important role in the process of understanding how individuals may coordinate and bring about conventions. Process models on the other hand indicate further lines of empirical research. Since they suggest that specific types of learning behavior may be important in the process of emergence of conventions, further experiments concerning the learning behavior of individuals are necessary.[37] To sum up, the suggestion here is that the formal apparatus of game theory should not be expected to provide full explanations of particular real world cases. While such partial models and explanations necessitate empirical research, empirical research is also in need of a general guiding framework.

4.5. A framework for understanding coordination

We may further argue that different models of coordination (e.g., with different assumptions concerning individual rationality and learning) can be considered as providing an understanding of the different aspects of coordination and convention in the model world. Hence the totality of these models can be considered as providing a general, albeit incomplete, framework for empirical research and for explanations of particular cases. Individual models study what is possible under different conditions. While one model studies whether rational individuals who adopt a simple learning rule may bring about conventions, another model studies this problem with boundedly rational individuals. Some models use uniform interaction where everyone has equal chance of interacting with every other, another model studies the same dynamics when individuals are more likely to interact with their neighbors. In some models there is no place for mistakes, in others individual mistakes are formulated in different ways. Thus, different models study different parts of the real world and they make more sense if they are considered together. The collection of different models of conventions can be considered as forming a general, albeit incomplete, model or theory of conventions. Hence the collection of these models can be considered as a general framework within which particular cases may be examined.

---

[37] It should be noted here that game-theoretic models have triggered a large number of experiments: For a good overview of the experimental literature see Crawford (1997). Some surveys on experimental games (especially prisoners dilemma games): Apfelbaum (1974), Colman (1982a), Gallo and McClintock (1965), Good (1991), Nemeth (1972), Pruitt and Kimmel (1977), Rapoport and Orwant (1962).

rather than another is
that general models of
al models portray the
in which they might be
search exactly for this
vs scientists to study
ividual behavior. From
mechanisms that bring
ole in the process of
t conventions. Process
rch. Since they suggest
rocess of emergence of
vior of individuals are
paratus of game theory
real world cases. While
h, empirical research is

ı (e.g., with different
can be considered as
ı and convention in the
as providing a general,
planations of particular
conditions. While one
earning rule may bring
h boundedly rational
ie has equal chance of
mics when individuals
s there is no place for
t ways. Thus, different
nore sense if they are
ions can be considered
onventions. Hence the
mework within which

nber of experiments: For a
eys on experimental games
lo and McClintock (1965),
962).

4.6. Interpretation of game theory

Our discussion of game-theoretic models of coordination and convention has also implications concerning the interpretation of game-theoretic models in general. In what follows these implications are discussed. Yet it should be noted that this is a preliminary discussion, only meant to suggest other research questions concerning game theory. An examination of other research areas that utilize the tools of game theory, as well as the concepts such as utility, payoffs etc. is needed in order to develop a good interpretation of game theory. Since this is not one of the tasks of this paper, we will only suggest what appears to be the most plausible interpretation given our discussion in this paper.

The classical interpretation of game theory is that games should represent the physical and institutional rules of the game in the real world. Yet we have seen in the previous pages that models of conventions and coordination do not reflect the physical and institutional rules in the real world, rather the rules of the game are usually the invention of the theorist. That is, these models do not provide a description of the environment within which a particular convention has emerged, they rather abstract from such factors.[38] 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. For example, the driving game considers only two options: left and right. Yet there is no guarantee that real individuals would conceive the situation in a similar manner in the case where driving conventions are nonexistent (e.g., see Sugden 1998a). In brief, the interpretation that games represent how agents perceive the situation does not apply.

Another interpretation of game theory suggests that it provides a framework for analysis (e.g., Schelling 1984, Binmore et al. 1993a). Schelling argues that anyone who tries to deal with the complex real world needs to isolate his model from some of these complexities. 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 1984: 215) it may be "valuable not as

[38] For example, Janssen argues:
"In the literature (e.g., industrial organisation) they do not seem to reflect rules of game in real world (neither rules of competition, nor legal and cultural constraints). The rules seem to be nothing but the invention of the theorist (who invents the game)." Janssen (1998a: 23)

'instant theory' just waiting to be applied but as a framework" (Schelling 1984: 241). Similarly according to Binmore *et al.* (1993a: 8) 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. By analogy to models in cosmology, evolution etc. they suggest that game theory involves

"[the] construction of models, [...] that make no claim at being demonstrably correct. Their purpose is to show only that a particular type of explanation is viable, in the sense that it can be expressed in a logically coherent manner." Binmore et al. (1993a: 5)

Considering the types of evolutionary models we have examined in this paper, Binmore *et al.* suggest that

"Such explanations are not testable in any real sense. They only provide *possible stylised explanations* of how things might have come about. [...]. But this can be a valuable insight, since the key to breaking out from the preconceptions that imprison our thought is often nothing more than the realisation that other ways of looking at things is intellectually respectable." Binmore et al. (1993a: 5 - 6)

The interpretation of game theory as a framework for analysis, or as providing stylized explanations is well in line with our analysis of coordination games.[39] Under this interpretation the collection of diverse game-theoretic models constitutes a framework for studying diverse issues in the real world; and a collection of the different game-theoretic models of coordination and convention may be considered as a framework for the analysis and explanation of particular conventions and for empirical research.

5. Concluding Remarks

In sum, the following arguments have been made in this paper:

- Static models of coordination (and convention) are concerned with examining the conditions under which certain outcomes are plausible, rather than explaining why and how such outcomes are brought about. Hence such models are in line with the end-state interpretation of the invisible hand.

- Dynamic models of coordination provide partial potential (theoretical) explanations of the emergence of coordination and conventions.

- Though these models examine whether successful coordination and conventions may emerge as unintended consequences of human action, this does not amount to a denial that conventions may be brought about intentionally. The interpretation of these models as providing partial potential explanations is well in line with this remark.

---

[39] It should be noted here that game theory is sometimes considered as a toolbox or as a collection of techniques for analysing strategic interaction. While this is an acceptable interpretation it does not tell us much about models that employ game theory.

ɔrk" (Schelling 1984: 241).
is a tool of investigation. It
ɔut the type of theorem that
etc. they suggest that game

ɔeing demonstrably correct.
ıation is viable, in the sense
ıore et al. (1993a: 5)

ıined in this paper, Binmore

nly provide *possible stylised*
But this can be a valuable
that imprison our thought is
's of looking at things is

'sis, or as providing stylized
nation games.[39] Under this
constitutes a framework for
the different game-theoretic
ed as a framework for the
pirical research.

ɔerned with examining the
er than explaining why and
re in line with the end-state

'theoretical) explanations of

ation and conventions may
oes not amount to a denial
erpretation of these models
this remark.

a toolbox or as a collection of
interpretation it does not tell us

• Explaining particular cases (e.g., explaining the emergence of a particular convention) necessitates empirical research. General models of coordination and conventions, however, need not be empirical or historical.

• The collection of different models of coordination and conventions may be considered as providing a general framework for empirical research and as providing singular explanations.

• In general game-theoretic models may be interpreted as a framework for analysis, rather than providing ultimate explanations concerning social phenomena and individual behavior.

The overall suggestion of this paper is that rather than seeing different models and accounts of institutions as alternatives to each other, one should try to see what may be gained by looking at the overall picture presented by their collection. Moreover, the accounts that present institutions as intended consequences need not be in conflict with the models that portray them as unintended consequences. The apparent conflict in these accounts disappears when we realize that the real world is complex and that social phenomena may unfold in various ways. The models we have examined in this paper consider only a few aspects of the real world in isolation from others. It would be farfetched to argue that what is possible in these small model worlds exhausts the possibilities in the real world. Thus, we have concluded these (process) models alert us to some of the possible ways in which conventions may emerge. On the other hand, the argument that 'institutions are intended' is commonly based on historical accounts of particular institutions. It would again be farfetched to argue that what seems to be true for some particular institutions is true for all. While it is true that more empirical and historical research is needed, this does not imply that abstract models of institutions are valueless. These models are necessary components of the research regarding institutions and they help us entertain and test our hypothesis concerning the emergence of institutions. Understanding what these models could accomplish and what they could not is important both for methodologists and practicing economists. Knowing the limits of these models would prevent unnecessary debates and facilitate constructive criticism.

REFERENCES

Apfelbaum, E. (1974) "On Conflicts and Bargaining", *Advances in Experimental Social Psychology* 7: 103 - 156.

Arthur, W. B. (1984) "Competing Technologies and Economic Prediction", *Options*. Laxenburg, Austria: International Institute for Applied Systems Analysis.

Arthur, W. B. (1985) "Clio and the Economics of QWERTY", *American Economic Review* 75 (2): 332-37.

Aumann, R. J. (1976) "Agreeing to Disagree", *Annals of Statistics* 4: 1236 – 1239.

Aumann, R. J. (1985) "What is Game Theory Trying to Accomplish?" in Arrow and Honkapohja (1985: 28 - 78).

Aumann, R. J. (1987) "Correlated Equilibrium as an Expression of Bayesian Rationality", *Econometrica* 55 (1): 1 – 18.

Aumann, R. J. and Brandenburger, A. (1995) "Epistemic Conditions for Nash Equilibrium", *Econometrica* 63: 1161 –1180.

Azariadis, C. and Drazen, A. (1990) "Threshold externalities in Economic Development", *Quarterly Journal of Economics* 105 (2): 501 – 526.

Bacharach, M. (1993) "Variable Universe Games", in Binmore, Kirman and Tani (1993b: 255 - 276).

Bacharach, M. (1994) "Report on EEEN-Related Research Apr. 1993 - Feb 1994", in *European Economics Experimental Research Network (EEEN) Project 1993-1994 Report.*

Bacharach, M. and Bernasconi, M. (1997), 'The Variable Frame Theory of Focal Points: An Experimental Study', *Games and Economic Behavior* 19: 1-45

Bacharach, M. and Stahl (1997), 'The Variable Frame Level-n Theory of Games', *FRAM Working Paper and working paper of Dept of Economics*, University of Texas at Austin

Berheim, D. (1984) "Rationalizable Strategic Behavior", *Econometrica* 52: 1007 – 1028.

Bicchieri, C. (1993) *Rationality and Coordination*, Cambridge: Cambridge University Press.

Bierman and Fernandez (1998) *Game Theory with Economic Applications*, Reading: Addison-Wesley.

Binmore, K and Samuelson, L. (2002) "The Evolution of Focal Points" *mimeo.*

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.

Brandenburger, A. (1992) "Knowledge and Equilibrium in Games", Journal of Economic Perspectives, 6: 83 – 101.

Brown, G. W. (1951) "Iterative Solutions of Games by Fictitious Play" in Koopmans, T. (ed.) (1951) *Activity Analysis of Production and Allocation*, New York: Wiley.

Carlsson, H. and van Damme, E. (1993a) "Equilibrium Selection in Stag-hunt games" in Binmore, K. G., Kirman, A. and Tani, P. (ed.) (1993) *Frontiers of Game Theory*, Cambridge: The MIT Press, pp. 237 - 254.

Carlsson, H. and van Damme, E. (1993a) "Global Games and Equilibrium Selection", *Econometrica* 61: 989 – 1018.

Casajus, A. (2001) Focal Points in Framed Games – Breaking the Symmetry, Berlin: Springer.

Cho, I-K., and Kreps, D. M. (1987) "Signalling Games and Stable Equilibria", *Quarterly Journal of Economics* 102: 179 – 221.

Colman, A. M. & Bacharach, M. (1997), 'Payoff dominance and the Stackelberg heuristic', *Theory and Decision* 43, 1-19

Colman, A. M. (1982a) "Experimental Games" in Colman (1982b: 113 - 140)

Colman, A. M. (1995) Game Theory and its Applications in the Social and Biological Sciences, Oxford: Butterworth & Heinemann.

Colman, A. M. (ed.) (1982b) *Cooperation and Competition in Humans and Animals*, Workingham: Van Nostrand Reinhold.

Crawford, V. and Haller, H. (1990) "Learning How to Cooperate: Optimal Play in Repeated Coordination Games", *Econometrica* 58: 571 – 596.

Crawford, V. and Haller, H. (1990) "Learning How to Cooperate: Optimal Play in Repeated Coordination Games", *Econometrica* 58: 571 – 596.

Crawford, V. P. (1997) "Theory and Experiment in the Analysis of Strategic Interaction", Kreps, D. M. and Wallis, K. F. (ed.) (1997) *Advances in Economics and Econometrics: Theory and Applications*. Seventh World Congress, Vol. I., Cambridge: Cambridge University Press, pp. 206 - 242.

Ellison, G. (1993) "Learning, Local Interaction and Coordination", *Econometrica* 61 (5): 1047-71.

Foster, D. and Young, P. H. (1990) "Stochastic Evolutionary Game Dynamics", *Theoretical Population Biology* 38: 219 – 232.

Fudenberg, D. and Harris, C. (1992) "Evolutionary Dynamics with Aggregate Shocks", Journal of Economic Theory 57: 420 – 441.

Fudenberg, D. and Levine, D. K. (1995) "Consistency and Cautious Fictitious Play", *Journal of Economic Dynamics and Control* 19: 1065 – 1090.

Fudenberg, D. and Levine, D. K. (1998) *The Theory of Learning in Games*, Cambridge: MIT Press.

Gallo, P. S. and McClintock, C. G. (1965) "Cooperative and Competitive Behavior in Mixed-motive Games", *Journal of Conflict Resolution* 9: 68 – 78.

Gauthier, D. (1975) "Coordination", *Dialogue* 14: 195-221.

Gintis, H. (2000) *Game Theory Evolving*, Princeton: Princeton University Press.

Good, D. A. (1991) "Cooperation in a Microcosm: Lessons from Laboratory Games", in Hinde, R. A. and Groebel, J. (1991) *Cooperation and Prosocial Behavior*, Cambridge: Cambridge University Press, pp. 224 - 237.

Goyal, S. and Janssen, M. C. W. (1996) "Can we Rationally Learn to Coordinate?", *Theory and Decision* (40): 29-49.

Goyal, S. and Janssen, M. C. W. (1997) "Non-Exclusive Conventions and Social Coordination", Journal of Economic Theory 77 (1): 34 – 57.

Greif, A. (1998) "Historical and Comparative Institutional Economics", *The American Economic Review, Papers and Proceedings* of the Hundred and Tenth Annual Meeting of the American Economic Association 88 (2): 80 – 84.

Güth, W., Schmittberger, R., and Schwarz, B. (1982) "An Experimental Analysis of Ultimatum Bargaining", *Journal of Economic Behavior and Organisation* 3: 367 – 388.

Harsanyi, J. and Selten, R. (1988) *A General Theory of Equilibrium in Games*, Cambridge: MIT Press.

Henrich, J., R. Boyd, et al. (2001). "In Search of Homo Economicus: Behavioral Experiments in 15 Small-Scale Societies." *American Economic Review* 91(2): 73 - 79.

Henrich, J., R. Boyd, et al. (2005). "'Economic Man' in Cross-cultural Perspective: Behavioral Experiments in 15 Small-scale Societies." *Behavioral and Brain Science*, Behavioral and Brain Sciences, 28: 795-855.

Jacobsen, H. J. (1996) "On the Foundations of Nash Equilibrium", *Economics and Philosophy* 12: 67 – 88.

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

Janssen, M. C. W. (1998b) "Focal Points", in Newman, P. (ed.) (1998) *The New Palgrave Dictionary of Economics and the Law*, London: Macmillan, pp.150-155.

Janssen, M. C. W. (2001a) 'Towards a Justification of the Principle of Coordination', *Economics and Philosophy*, 2001 (17), pp.221-234.

Janssen, M. C. W. (2001b) "Rationalizing Focal Points", *Theory and Decision*, 2001 (50) 1: 119-148.

Kalai, E. And Lehrer, E. (1993a) "Rational Learning Leads to Nash Equilibrium", *Econometrica* 61: 1019 - 1045.

Kalai, E. And Lehrer, E. (1993b) "Private-Beliefs Equilibrium", *Econometrica* 61: 1231 - 1240.

Kandori, M. and Rob, R. (1995) "Evolution of Equilibria in the Long Run: A General Theory and Applications", *Journal of Economic Theory* 65: 383 – 414.

Kandori, M., Mailath, G. J. and Rob, R. (1993) "Learning, Mutation and Long Run Equilibria in Games", *Econometrica* 61: 29 – 56.

Kaniovski, Y. and Young, P. H. (1995) "Learning Dynamics in Games with Stochastic Perturbations", Games and Economic Behavior 11:330 – 363.

Krishna, V. and Sjostrom, T. (1995) "On the convergence of Fictitious Play", *mimeo*, Harvard University.

Krugman, P. (1991) "History versus Expectations", Quarterly Journal of Economics 106: 651- 667.

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

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

Mailath, G. J. (1992) "Introduction: Symposium on Evolutionary Game Theory", *Journal of Economic Theory* 57: 259 – 277.

Mailath, G. J. (1998) "Do People Play Nash Equilibrium? Lessons from Evolutionary Game Theory", *Journal of Economic Literature* XXXVI: 1347 – 1374.

Marimon, R. (1997) "Learning from Learning in Economics", in Kreps, D. M. and Wallis, K. F. (ed.) (1997) *Advances in Economics and Econometrics: Theory and Applications*. Seventh World Congress, Vol. I., Cambridge: Cambridge University Press, pp. 278 - 315.

Marimon, R., E. McGrattan, *et al.* (1990). "Money as a Medium of Exchange in an Economy with Artificially Intelligent Agents." *Journal of Economic Dynamics and Control* 14: 329 - 373.

Mehta, J.; Starmer, C. and Sugden, R. (1992) "An Experimental Investigation on Focal Points in Coordination and Bargaining" in *Decision making Under Risk and Uncertainty: New Models and Emprical Findings*. ed. J. GEWEKE, Dordrecht: Kluwer.

Mehta, J.; Starmer, C. and Sugden, R. (1994a) "The Nature of Salience: an experimental Investigation of Pure Coordination Games", *American Economic Review* 84: 658- 673.

Mehta, J.; Starmer, C. and Sugden, R. (1994b) "Focal Points in Pure Coordination: An Experimental Investigation", *Theory and Decision* 36: 163-85

Milgrom, P. and Roberts, J. (1991) "Adaptive and Sophisticated Learning in Normal Form Games", *Games and Economic Behavior* 3: 82 100.

Nemeth, C. (1972) "A Critical Analysis of Research utilizing Prisoner's Dilemma Paradigm for the Study of Bargaining", *Advances in Experimental Psychology* 6: 203 - 234.

North, D. (1990) Institutions, Institutional Change and Economic Performance, Cambridge University Press,.

Pruitt, D. G., and Kimmel, M. J. (1977) "Twenty Years of Experimental Gaming: Critique, Synthesis, and Suggestions for the Future", *Annual Review of Psychology*, 28 363 – 392.

Rappoport, A. and Orwant, C. (1962) "Experimental Games: A Review", *Behavioral Science* 7: 1 – 37.

Robinson, J. (1951) "An Iterative Method of Solving a Game", Annals of Mathematics 54: 296 – 301.

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

Samuelson, L. (1998) *Evolutionary Games and Equilibrium Selection*, Cambridge: MIT Press.

Schelling, T. C. (1958) "The Strategy of Conflict Prospectus for a Reorientation of Game Theory", *The Journal of Conflict Resolution* 2 (3): 203 – 264.

Schelling, T. C. (1960) *The Strategy of Conflict*. Cambridge, MA: Harvard University Press.

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

Schotter, A. (1981) *The Economic Theory of Social Institutions*. New York: Cambridge University Press.

Selten, R. (1975) "Reexamination of the perfectness concept for equilibrium points in extensive-form games", *International Journal of Game Theory* 4: 25 – 55.

Sidowski, J. B. (1957) "Reward and Punishment in a Minimal Social Situation", *Journal of Experimental Psychology* 54: 318 - 326.

Sidowski, J. B., Wyckoff, L. B., and Tabory, L. (1956) "The Influence of reinforcement and Punishment in a minimal social situation", *Journal of Abnorbal and Social Psychology* 54: 318 - 326.

Stahl, D. (1993) "Evolution of Smart Players", *Games and Economic Behavior* 5, 607 - 617

Sugden, R. (1991) "Rational Choice: A Survey of Contributions from Economics and Philosophy", *Economic Journal* 101: 751 –786.

Sugden, R. (1995) "A theory of Focal Points", *Economic Journal* 105: 533-50

Sugden, R. (1998a) "The role of Inductive Reasoning in the Evolution of Conventions", *mimeo*.

Sugden, R. (1998b) "Normative Expectations: the simultaneous evolution of institutions and norms" in Benner and Putterman (1998: 73 - 100).

Sugden, R. (2001). "Ken Binmore's Evolutionary Social Theory." *The Economic Journal* 111: F213 - F243.

Tirole, J. (1996) "A theory of Collective Reputations (with Applications to the Persistence of Corruption and to Firm Quality)", *Review of Economic Studies* 63 (1): 1 – 22.

Young, H. P. (1993) "The Evolution of Conventions", *Econometrica* 61: 57 – 84.

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

Young, P. H. (2001) "Dynamics of Conformity" in Durlauf, S. N. and Young, P. H. (2001) *Social Dynamics*, Cambridge: The MIT Press, pp. 133 – 154.

SECOND INTERNATIONAL CONFERENCE ON BUSINESS, MANAGEMENT AND ECONOMICS

2005 • 2006 • 2007 • 2008

ICBME

ADVANCES IN ECONOMICS: THEORY AND APPLICATIONS

• Edited by Coskun Can Aktan •

VOLUME 2

Selected Proceedings of the Second International Conference on Business, Management and Economics, Organized by Yasar University 15 - 18 June 2006, Cesme - Izmir, Turkey

YASAR UNIVERSITY

Cataloging-in-Publication Data

Advances in Economics:
Theory and Applications
Volume 2:
Selected Proceedings of the Second International Conference on Business, Management and Economics, Organized by Yasar University
15-18 June 2006, Cesme-Izmir, Turkey

Edited by Coskun Can Aktan

ISBN: 975-6339-06-3

First Edition:
December - 2006

Cover Design:
Tansel Ozalp

Printed in Turkey:
Birleşik Matbaacılık
0 232 4336866
e-mail : birlesikmatbaa@hotmail.com

CONTENTS