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Dissertation Title: *Bounded Memory, Learning, and Reputation*

Committee:
Professor Benjamin Polak
Professor Dirk Bergemann
Professor Stephen Morris

Expected Completion Date: May 2007

Degrees:
Ph.D., Economics, Yale University, Expected May 2007
M.Phil., Economics, Yale University, Dec 2004
M.A. Economics, Yale University, Dec 2003
B.A., Economics, University of Sao Paulo, Dec 2000

Fellowships, Honors and Awards:
Yale University Dissertation Fellowship, Fall 2006
Yale University Summer Fellowship, 2002, 2003 and 2006
Yale University Fellowship, 2002-2007

National Council of Research Fellowship (CNPq Brazil) 2000

Teaching Experience:

Teaching Assistant, Intermediate Microeconomics, Fall 2003, Spring 2005, Fall 2005
Teaching Assistant, Introductory Microeconomics, Spring 2004, Spring 2006

Research Experience:

Research Assistant, Professors Dirk Bergemann and Stephen Morris, 2004
Research Assistant, Professor Denisard Alves, University of Sao Paulo, 2001

Other Experience:

Boston Consulting Group, New York , August, 2005
BBA Creditanstalt, Investment Bank, Sao Paulo, 2000
Business Management Study Group, Yale University, 2005

Conference Presentations:

European Meetings of the Econometric Society, Vienna, August 2006
International Conference on Game Theory, Stony Brook, July 2006
North American Meetings of the Econometric Society, University of Minnesota, June 2006
Canadian Economic Theory Conference, University of Toronto, May 2006
Midwest Economic Theory Conference, Michigan State University, April 2006
Zeuthen Workshop on Behavioral Economics, University of Copenhagen, May 2005
Yale Theory Lunch, Fall and Spring 2004, 2005 and 2006
Yale Summer Presentation, 2005 and 2006
Yale Prospectus Applied Workshop, Fall 2003

Professional Experience:

Referee for *The Economic Journal*

Papers:

"Reputation and Bounded Memory," [job market paper], Yale University, 2006.

"Bounded Memory and Limits on Learning," Yale University, 2006.

"Learning in Hidden Markov Models with Bounded Memory," (with Maher Said), in progress, Yale University, 2006.

"Commitment and Reputation in a Credibility Model," in progress, Yale University, 2006.

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Dissertation Abstract:

I study the implications of bounded memory in games. A typical assumption in economics is that people have a perfect memory. In models of long-term relationships, players condition their strategies on the entire history of the game, irrespective of how long and complicated that history may be. Yet, in reality, most people forget things. They categorize. They often ignore information and their updating may be infrequent. I study a model of bounded memory that captures these features.

Throughout my dissertation, memory is modeled as a finite set of states. All the agent knows about the history of the game is her current memory state. The player's strategy is to choose an action rule, which is a map from each memory state to the set of actions, and a transition rule from state to state. First, I characterize the equilibrium memory rule in a reputation game and show that it may induce inertia and infrequent updating, sometimes for strategic reasons. Second, I show that in a long-term relationship, learning (or type separation) is never complete, in contrast to recent results in reputation games.

I view both action choice and updating rule as a conscious process, unlike the literature on finite automata that assumes commitment to the ex-ante strategy. Therefore, the player in my model is subject to sequential rationality constraints. The action chosen at each state must be optimal given the beliefs at that state. And, the transition rule from each state must be optimal given the beliefs at that memory state and taking as given the strategy—both action and transition rules—at all her states. The reason for taking the strategy at all states as given when deciding on an action or on which state to move is that if an agent deviates today, she will not remember it tomorrow. This idea of sequential rationality constraints in bounded memory comes from Piccione and Rubinstein (GEB 1997) and Wilson (2003), but these authors studied single-person decision problems. Here I study games, where the inability to commit matters.

In the first chapter, "**Reputation and Bounded Memory**" (*job market paper*), I focus on reputation games, where one player is trying to learn her opponent's type (for example, repeated games with incomplete information). In these games memory plays a central role, since remembering the exact history of the game is important for learning. The setting is a repeated zero-sum game with two players, one of whom has bounded memory. She faces a player who, with some exogenous prior probability, is

committed to a pure strategy. This game is based on Sobel's (RES 1985) credible advice model, in which a policy maker is uncertain about her adviser's preferences.

I characterize the equilibrium action and updating rule in this game. I show that the bounded memory player must have beliefs about her opponent's type that are one and zero in her two "extreme" memory states. The transition rule from state to state must satisfy a weak monotonicity property; hence, the resulting endogenous updating rule will resemble Bayesian updating whenever possible.

When the number of memory states is not "large enough," the player will use randomization in her transition rule before reaching the extreme states. After a signal, the player randomizes between updating and remaining on the same state. This leads to infrequent updating and "inertia" on the player's behavior. Similar to single-person games, randomization can be interpreted as a memory-saving device: with no capacity to store all the informative signals, the player optimally decides to discard some of them. However, I show that, in games, there is an additional strategic role for randomization. It is used as a screening device: the player is "testing" the opponent before updating.

The second chapter, "**Bounded Memory and Limits on Learning**," contributes to the literature on reputation and repeated games with incomplete information. A celebrated recent result in this literature is that, asymptotically, the play of the game converges to the play of a complete information game (see Cripps et al. (EMA 2004), for example). This means that players can profit from a "false" reputation only in the short-run. Constant opportunistic behavior will lead to statistical revelation of the actual type, which means no long-run reputation.

The setting is very similar to that in the previous chapter. Here, the bounded memory agent faces a player who, with some exogenous probability, might be committed to a mixed strategy, instead of a pure strategy. This difference is analogous to the distinction between games with perfect monitoring versus imperfect monitoring.

I show that under bounded memory, we will not have full learning (or type separation), even in the long run. The main intuition for this result is that with bounded memory the agent can hold only a finite number of beliefs in equilibrium. And, these beliefs cannot be too far apart from each other, or else the sequential rationality constraints would not be satisfied. Therefore, with initial uncertainty about types and bounded memory on the uninformed player, long-term reputations can be sustained even in the extreme case in which agents have opposite preferences.

Finally, the third chapter of my dissertation, "**Learning in Hidden Markov Models with Bounded Memory**" (joint with Maher Said), is in a rather different setting. We study a decision problem in which an agent takes decisions every period in a changing world. The agent receives signals about the true state of the world that is changing according to an underlying Markov process. We aim to find the optimal memory rule and compare it with the one obtained in a pure hypothesis testing problem, solved in Hellman and Cover (AMS 1970) and Wilson (2003).