Economic History and Game Theory: a Survey

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Comments Are Welcome

Abstract

This paper surveys the small, yet growing, literature that employs game theory for economic history analysis. It elaborates on the promise and challenge of integrating game theoretical and economic history analyses and presents the approaches taken in conducting such an integration. Most of the essay, however, is devoted to presenting studies in economic history that utilize game theory as their main analytical framework. Studies are presented based on their substance to highlight the range of potential topics in economic history that can be and had been enriched through a game theoretical analysis.

Introduction:

During the Cliometric Revolution of the mid 60s the nature of economic history was substantially transformed) quantitative analysis conducted within the theoretical framework provided by neo-classical economics became the backbone of economic history.[1] The period of the ascension of Cliometrics within economic history coincided with the period in which game theory established itself as an integral part of economic theory. It is within the context of these developments in economic history and game theory that their inter-relations should be comprehended.

Game theory has the promise of substantially enriching economic history by providing it with the tools required to expand its domain beyond the confines imposed by neo-classical theory and the need to substantiate hypotheses only through econometric analysis. It provides a theoretical framework suitable for analyzing strategic situations that still prevail in modern economies and were probably even more prevalent in pre-modern economies. More generally, game theory indicates a role for history in economic systems by pointing, for example, to the potential sensitivity of outcomes to rules and hence a role for institutions, the possibility of multiple equilibria and hence the potential for distinct trajectories of institutional and economic changes, the crucial role of expectations and beliefs and hence the potential importance of the historical actors, and the possible role of evolutionary processes and change in equilibrium selection. At the same time, the particular features of game theory) especially the potential non-robustness and inconclusiveness of its empirical predictions) makes its application to empirical, historical study challenging.

Integrating game theory and economic history can potentially also enrich game theory. History contains unique and, at times, detailed information regarding behavior in strategic situations. Hence, history provides another laboratory to examine the relevance of game theory to positive economic analysis. Historical analyses guided by game theory are likely to point to theoretical issues that, if addressed, would contribute to the development of game theory and its ability to advance economic analysis in general.

This essay surveys the small, yet growing, literature that employs game theory for economic history analysis. Section I briefly elaborates on the promise and challenge of integrating game theoretical and economic history analyses and presents the approaches taken in conducting such an integration. Most of the essay, however, is devoted to presenting studies in economic history that utilize game theory as their main analytical framework. Hence, this survey will not present the many economic history studies that utilize general game theoretical insights) such as the possibility of coordination failure or the importance of credible

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[1] On the Cliometric Revolution, see Williamson (1994). Hartwell (1973) surveys the methodological developments in economic history. For the many contributions generated by of the neo-classical line of research in economic history, see McCloskey (1976).

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commitment) to identify the questions that have to be addressed.[2] Because the appropriateness of using game theory to "frame" questions in economic history seems to be non-controversial, such studies will not be covered in this survey.

Accordingly, section II of this survey covers studies that utilize game theory as their main analytical framework or examine the empirical relevance of game theoretical insights. These studies are presented by the issues in economic history they examine. Clearly, it is impossible to extensively elaborate on a myriad of papers in such a short essay. Accordingly, a short description of each paper is provided and only a few papers are described in detail. Their (subjective) selection is influenced by their relative complexity, methodological contribution, or representativeness. Finally, since this essay aimed only at surveying applications of game theoretical analysis to economic history, it does not attempt to systematically evaluate their arguments. Evaluation is provided only with respect to the integration of game theoretical and historical analyses (although references to published comments on papers are provided.)

I.   Game Theory and Economic History: Bringing Two Ends Together

The potential contribution of game theory to economic history is large. More accurately, economic history can benefit greatly from a theory enabling empirical analysis of strategic situations since issues central to economic history are inherently strategic. For example, one of the distinct features of economic history since its emergence has been its concern with the origin, impact, and path dependence of (non-market) economic, social, political, and legal institutions.[3] Yet, institutional analysis often requires a theory of strategic behavior. Examining the merchant gild, for example, requires analyzing strategic interactions among rulers and merchants and among merchants themselves. More broadly, economic historians, inspired Adam Smith, often identify the rise of the modern economic system with the expansion of the market system. This view implies, however, that an analysis of non-market situations is required to comprehend past economies, their functioning, and their transformation to market economies. Hence, theoretical framework able to advance an empirical analysis of strategic situations can expand our comprehension of issues central to economic history.

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[2] See for example, North (1981), chapter 3 and Kantor (1991). "The power of game theory - and it's the way I've used it - is that it makes you structure the argument in formal terms, in precise terms..." (North, 1993, p. 27).

[3] For a discussion of the methodological differences between economic history and economics, see, Backhouse (1985), pp. 216-21. For institutional studies during the 19th century in the German and English Historical Schools, see, for example, Weber (e.g. 1987 [1927]); Cunningham, (e.g., 1882). On the general theory of path dependence see David (1988, 1992).

The ability of game theory, the existing theoretical framework for analyzing strategic situations to advance an empirical and historical study should be judged empirically. Yet, certain conclusions of game theoretical analysis make its application to economic history both particularly challenging and promising. Game theory indicates that outcomes in strategic situations are potentially very sensitive to specification, that various equilibrium concepts are plausible, and (given an equilibrium concept) multiple equilibria may exist. These conclusions imply that application of game theory to economic history may be particularly difficult since economic history is, first and foremost, an empirical field and economic historians seek to comprehend what has actually transpired, why it transpired, and to what effect. One may argue that a theoretical analysis whose conclusions regarding outcomes are non-robust and are empirically inconclusive (in the sense that many outcomes are consistent with the theory) provides an inappropriate foundation for an empirical study.

Interestingly, the game theoretical conclusions regarding non-robustness and inconclusiveness are in accordance with the conceptual foundations of historical analysis, namely, that outcomes depend on the details of the historical context, that "economic actors" can potentially matter, and that non-economic aspects of the historical context, such as religious precedents or even chance, can impact economic outcomes. Game theory provides economic history with an explicit theoretical framework that does not lead to the a-historical conclusion that the same preference, technology, and endowment lead to a unique economic outcome in all historical episodes. The conclusions of game theoretical analysis that challenge its empirical applicability make it a theory particularly promising for historical analysis since it can be used for analyzing strategic situations in a manner sensitive to their historical dimensions.

Scholars who have applied game theory to economic history differ in their responses to the challenge and promise presented by the potential non-robustness and inconclusiveness of game theoretical analysis. To integrate game theory and economic history they all began with a historical study aimed at formulating the relevant issue to be examined. Some studies, after identifying the relevant issues to be examined, confronted the non-robustness and inconclusiveness problems by guiding their empirical analysis using generic, robust game theoretical insights.[4] Their empirical analyses pointed to some important strategic features of the historical situation, such as the need to negotiate in the presence of asymmetric information, but did not provide the foundation for an explicit model of the situation. The empirical investigation was then guided by generic insights applicable in situations with such features. An example for such general insights would be that bargaining in the presence of asymmetric information can lead to negotiation failure. Reliance on general insights comes at the cost of limited ability to empirically substantiate a hypothesis. Without an explicit

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[4] For somewhat similar approach in the Industrial Organization literature, see Sutton (1992).

model it is difficult to enhance the confidence in an argument by confronting the details of the historical episode with the details of the theoretical argument and its implications. In particular, without specifying the strategies employed by the players, it is difficult to empirically substantiate the analyses. Yet, the potential benefit of relying on general insights is the ability to discuss important situations without being constrained by the ability to explicitly model them.

Other studies found it useful to confront the non-robustness and inconclusiveness by utilizing a context-specific model. They conducted a detailed empirical study of the historical episode under consideration, and this study provided the foundation for an interactive process of theoretical and historical examination aimed at formulating a context-specific model that capture an essence of the relevant strategic situation.[5] The interactive historical and theoretical analysis served to sufficiently constrain the model's specification, to base the model on assumptions in which confidence could be gained independently from their predictive power, and to ensure that the analysis did not impose the researcher's perception of a situation on the historical actors.[6] This context-specific model provided the foundation for a game theoretical analysis of the situation while enhancing the examination of the extent to which its main conclusions are robust with respect to assumptions whose appropriateness is questionable historically.

To address the problem arising from the existence of various equilibrium concepts, most of these applications of game theory to economic history utilized two basic equilibrium concepts, Nash equilibrium and sub-game perfect equilibrium. The advantage of these equilibrium concepts is that they are inclusive of most other equilibrium concepts and have intuitive, common sense interpretations.[7] Yet, using these inclusive equilibrium concepts implies that multiple equilibria are more likely to exist. When multiple equilibria exist, they imply two problems for empirical historical analysis: identification and selection. Some studies only pointed to the existence of an equilibrium with the features associated with the behavior the analysis comprehends. In other studies, the need to identify a particular strategy was avoided by concentrating on the analysis of the equilibrium set.[8] This approach has been adopted particularly in studies that examine the

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[5] Clearly, the essence of the issue which is captured should be both important and orthogonal to other relevant issues.

[6] For example, the King of England, Edward the First, noted in 1283 that insufficient protection to alien merchants' property rights deterred them from coming to trade. His remark enhances the confidence in the relevance of a model in which commitment to alien traders' property rights can foster their trade (Greif et al. 1994).

[7] For an introduction to these concepts, see, for example, Fudenberg and Tirole (1991) or Rasmusen (1994).

[8] See, for example, Greif et al. (1994), particularly proposition 1.

impact of changes in the rules of the game on outcomes.[9] To evaluate the impact of a change in the rules, these studies examined its impact on the equilibrium set. In other cases, the problem of identification has been confronted by employing direct and indirect evidence to verify the use of a particular strategy (or some sub-set of the possible equilibrium strategies with particular features).

Direct evidence is explicit documentary accounts reflecting the strategies utilized or intended to be utilized by the decision makers.[10] Such statements were found in diverse historical sources such as business correspondence, private letters, legal procedures, gild's constitutions, firms' charters, and records of public speeches. Clearly, statements about intended courses of action can reflect "cheap talk." Yet, a confidence in the empirical relevance of a strategy can be enhanced by indirect evidence. Indirect evidence is an empirical confirmation of predictions generated under the assumption that a particular strategy was employed. Economic history studies utilizing game theory generated predictions with respect to a wide range of variables such as price movements, contractual forms, dynamics of wealth distribution, exits, entries, price, and other responses to exogenous changes. In some studies it was possible to test such predictions econometrically but in other studies, because of the nature of their predictions such tests could not be performed.[11] While the advantage of confirming a prediction based on an econometric test is having a test of significance it comes at the cost of restricting predictions only to those that can be tested econometrically. In any case, both types of predictions can, in principle, be compared with those generated under alternative hypotheses. Generating falsifiable predictions, as well as the ability to check robustness and to perhaps gain a deeper understanding of the issues under consideration, are among the advantages of having a context-specific model (relative to "general insight" analysis). Yet, this comes at the cost of restricting the analysis to cases where such models can be formulated.

The manner in which selection has so far been handled is influenced more by the conceptual foundations of historical analysis than by the game theoretical literature regarding refinements or evolutionary game theory. Most authors found it useful to account for the selection of a particular equilibrium by invoking aspects of the historical context. One paper invoked the public commitment of Winston Churchill to a particular strategy as selecting an equilibrium.[12] Other papers pointed out that factors outside the game itself

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[9] E.g., Milgrom, et. al. (1990); Greif, et. al. (1994).

[10] For extensive use of such evidence, see Greif (1989).

[11] For examples of econometric analyses see Porter (1983); Levenstein (1994). For non econometric analyses see Greif (1989, 1993, 1994a), Rosenthal (1992).

[12] Maurer (1992).

influenced equilibrium selection. Among these factors were immigration that provided information networks, political changes that determined the initial set of players, and focal points provided by religious and social attitudes.[13] Some authors, particularly those interested in comparing two historical episodes, theoretically identified the range of parameters or variables that were required for one particular equilibrium to prevail rather than another. This theoretical prediction was confronted with the empirical evidence regarding these variables in the historical episodes under consideration.[14]

The next section presents studies in economic history that employ game theory. In line with the above discussion of the methodology employed by such studies, they are grouped according to those that employ "general insights" (sub-section II1) and those that employ "context-specific models" (sub-section II2). In both sections the presentation is organized by historical topics but it implicitly suggests the potential benefits of economic history studies utilizing game theory to further empirical evaluation and extension of various aspects of the theory itself. I will return to this issue below. While space limitation precludes detailed examination of all the papers in either section, to illustrate the methodological differences between the papers in the two sub-sections, it is perhaps best to elaborate at somewhat greater length on one particular study (Greif, 1989, 1993, 1994a) in which the context-specific models' methodology is well reflected.

II.   <u>Game Theoretical Analyses in Economic History</u>.

1)   The Early Years: Employing General Game Theoretical Insights.

The first economic history papers that employed general insights from game theory were published in the early 1980s.[15] In terms of their empirical investigation they examined regulations, market structure, and property rights protection. With respect to game theory, they indicated that it may be empirically beneficial to consider nested games, namely, a situation in which the rules of one game are the equilibrium outcome of another game, and that rules determined in one period may provide the initial conditions for the rules of the game in a subsequent period. Furthermore, they provide empirical evidence of problems encountered in bargaining under incomplete information and suggested that off-the-path-of-play expected behavior may indeed impact economic outcome thereby lending empirical support to the notion of sub-game-perfect equilibrium.

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[13] E.g., Greif (1994a).

[14] E.g., Rosenthal (1992); Greif (1994a); Baliga and Polak (1995).

[15] Some earlier works employed cooperative game theory for historical analysis but these works did not come to maturity. For prominent attempts of this kind, see David (1982) and David and Sundstrom (1984).

Regulations: The importance of the historical development of regulatory agencies and regulations in the US have been emphasized by economic historians for a long time. Davis and North (1971), for example, argued that it was a welfare enhancing process of institutional changes driven by potential profit from regulating the economy. In sharp contrast, utilizing a game theoretical analysis of endogenous regulations, Reiter and Hughes (1981) have argued that the process was not necessarily welfare enhancing. In their formulation of the situation, economic agents and regulators are involved in a non-cooperative dynamic game with asymmetric information in which the less well-informed regulators pursue their own agendas. To advance their agendas, they are also involved in a cooperative game with political agents in which they try to influence the political process through which the next period's legal and budgetary framework of the non-cooperative game is determined. While Reiter and Hughes did not attempt to explicitly solve the model, it provided them with a paradigm to discuss the emergence of the "modern regulated economy" as reflecting redistributive considerations, efficiency enhancing motives, and political reasons.

Market Structure: A market's structure is fundamental in determining an industry's performance and conduct. Traditionally, economic historians have not considered that a market structure can be influenced by strategic interactions. Yet, Carlos and Hoffman (1986) argued that strategic considerations determined the structure of the fur industry in north America during the early 19th century. The two companies that operated in this industry from 1804 to 1821 (the Northwest Company and the Hudson's Bay Company) could have benefitted from collusion or merger and there was no antitrust legislation to hinder either. Yet, the two companies were engaged in intense conflict that led to a depletion of the animal stock.

Carlos and Hoffman argued that the persistence of this market structure reflects the difficulties of bargaining with incomplete information. General insights from bargaining models with incomplete information indicate that it is possible to fail to reach an *ex post* efficient agreement due to each side's attempt to mis-represent its type, players are likely to bargain over distributive mechanisms rather than allocations, and disagreement may result from a player's commitment to a "tough" strategy. Indeed, although the correspondence between the companies indicates that both recognized the gains from cooperation, each side was trying to mislead the other regarding its situation. Furthermore, the two companies did not bargain over the allocation of joint profits but tried to reach a merger. Following the failure to merge, they bargained over a distribution of the territory that each would exploit as a monopolist. Also, negotiation prior to 1821 broke down partially due to the Hudson's Bay Company's commitment to a particular, very demanding strategy. The direct impetus for a final merger was the intervention of the government that followed a period of intense competition. Hence, Carlos and Hoffman's analysis indicates that strategic considerations impacted the market's structure and provided "empirical evidence on the problems encountered in bargaining under

incomplete information" (p. 968).[16]

Security of Property Rights: Financing the government by issuing public debt is one of the peculiar features of the pre-modern European economy. Arguably, this type of financing facilitated the rise of security markets (e.g., Neal, 1990) and provided the foundation for the modern welfare state. Yet, for a pre-modern ruler to gain access to credit he had to be able to commit to repay it despite the degree to which he stood above the law. How could rulers commit to repay their debt? Why in some historical episodes did rulers renege on their obligations and in others respect them? Clearly, in a one shot game between a ruler (who can request a loan and renege after receiving it) and a potential lender (who can decide whether or not to loan), the only sub-game perfect equilibrium entails no lending.

Veitch (1986) has argued (based on Telser's (1980) idea of self-enforcing agreements) that repetition and potential collective retaliation by lenders enlarged the equilibrium set and enabled rulers to commit to repay their debts, and hence, to borrow. He has noted that in medieval Europe rulers often borrowed from members of a particular group, such as the Jews, Templars, or the Italians, while debt repudiation was often carried out against the group as whole rather than against particular members.[17] Veitch argued that this indicates that repudiation was curtailed by the threat of collective retaliation by the group. The threat was credible due to the ethnic, moral, or political relations among the lenders. The threat was effective as long as the ruler did not have any alternative group to borrow from, implying that the emergence of an alternative group would lead to repudiation against the previous group as indeed was often the case.[18] Similarly, Root (1989) argued that corporate bodies, such as village communities, provincial estates, and guilds enabled the King of France to commit to pay debts during the 17th and 18th centuries. They increased the opportunity cost of breach thereby restraining the King's ability to default and enabling him to borrow. Indeed, the rise of corporate bodies that loaned to the King in the 18th century were associated with a lower interest and bankruptcy rate relative to the 17th century.

North and Weingast (1989) and Weingast (1995) further expanded the study of the relations between credible commitment, property rights security, and political power. If indeed security of property rights is a

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[16] The analysis is based on Myerson's (1984a, 1984b) work on a generalized Nash bargaining solution and Crawford's (1982a) model in which it is costly (for exogenous reasons) to change a strategy after committing to it. As Carlos and Hoffman (1988) later recognize in their response to Nye (1988), subsequent theoretical developments provided models better suited to capture the essence of the historical situation.

[17] Or against a particular sub-group such as an Italian company.

[18] This insightful and novel analysis is incomplete. For example, it is mistaken in arguing that a self-enforcing agreement among the Italian companies is a necessary condition for a sub-game perfect equilibrium in which the ruler does not repudiate.

key to economic growth (as conjectured by North and Thomas, 1973), how could such security be achieved in past societies governed by kings with military power superior to that of their subjects? North and Weingast argued that the Glorious Revolution of 1688 enabled the King of England to commit to such security, thereby providing institutional foundations for growth.

During this revolution and the years of civil war prior to it, the Parliament established its ability and willingness to revolt against a king who abused property rights. This enabled the king to commit to the property rights of his subjects. Furthermore, to enhance the credibility of this threat and to limit the king's ability to renege, various measures were taken. The king's rights were clearly specified to foster coordination among members of the Parliament regarding what actions of the king should trigger a reaction. The Parliament gained control over taxation and revenue allocation, an independent judiciary was established, and the king's prerogatives were curtailed. In support of the view that the Glorious Revolution enhanced property rights' security, North and Weingast pointed to the rise, during the eighteenth century, in sovereign debt and in the number and value of securities traded in England's private and public capital markets and a general decline in interest rates.[19]

2)   Coming to Maturity: Explicit Models
Exchange and Contract Enforcement in the Absence of a Legal System

Despite the prevalence of exchange and contract enforcement in the absence of a legal system in past and present economies, their examination has not been advanced in economic history due to the lack of appropriate theoretical framework. Among the first economic history papers that utilized explicit models are those that employed symmetric and asymmetric information repeated game models to examine institutions that governed informal contract enforcement in various historical episodes. Although multiple equilibria usually exist in such games they were found to facilitate empirical examination when the historical information sufficiently constrained the model, when the analysis concentrated on the equilibrium set, and when the historical records were rich enough to enable identification of the equilibrium that prevailed. Apart from indicating the empirical relevance of repeated games (with and without imperfect monitoring), these studies demonstrate the extent to which game theoretical analysis can highlight diverse aspects of a society, such as the inter-relations between economic institutions and social structures. They indicate how a third

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[19] Carruthers (1990) criticized the claim that placing limits on the King enabled England to borrow, while Clark (1995) cast doubts on the claim that property rights were insecure prior to 1688. He examined the rate of return on private debt and land, and the price of land from 1540 to 1800, and was unable to detect any impact from the Glorious Revolution. Weingast (1995) applied the model of Greif et. al. (1994) to further examine how constitutional changes during the Glorious Revolution enhanced the King's ability to borrow by increasing his ability to commit.

party enforcement can be made credible even in the absence of incomplete information, or a strategy calling to punish one who failed to punish a deviator. Finally, they indicate that it is misleading to view contract enforcement based on formal organizations and on repeated interaction as substitute, since formal organizations may be required for long hand of the future to sustain cooperation.

"Coalitions" and informal contract enforcement: Much of the spectacular European growth from the eleventh to the fourteenth centuries is attributed to the Commercial Revolution) a resurgence of Mediterranean and European long-distance trade. The actions and explicit statements of contemporaries indicate that in this trade expansion overseas agents played an important role by managing merchants' capital abroad. Operating through agents, however, required overcoming a commitment problem since agents who had control over others' capital could act opportunistically. For efficient agency relations to be established an agent had to commit *ex ante* to be honest *ex post* and not to embezzle the merchant's capital (in the form of money, goods, and expensive packing materials). It is tempting to conclude, as Benson (1989) has argued, that reputation permitted such a commitment. Yet, such an argument is unsatisfactory since it presents an incomplete theoretical analysis and, more importantly, implicitly it claims that it is sufficient to comprehend a historical situation by only examining a theoretical possibility without any empirical evidence. Comprehending how the merchant-agent commitment problem was mitigated in a particular time and place (in which it was indeed mitigated) requires detailed empirical research and a context specific theoretical analysis.

Among the issues that a satisfactory empirical and theoretical analysis should address are the following. If repetition enabled cooperation, should the model be of infinite or finite horizon? If an infinitely repeated game is appropriate, how was the unraveling problem mitigated (namely, why wouldn't an agent cheat in old age)? Should the model be an incomplete information model? Should it include a legal system? How was information acquired and transmitted? Should the set of traders and agents be considered exogenous? Could an agent begin operating as a merchant with goods he had embezzled? Who was to retaliate if an agent embezzled goods? Why was the threat of retaliation credible? What were the efficiency implications of the particular manner in which the merchant-agent commitment problem was mitigated? Why did this particular manner emerge?

Greif (1989, 1993, 1994a) examined these and related questions with respect to the Jewish Maghribi traders who operated during the eleventh century in the Muslim Mediterranean. The historical and theoretical evidence indicates that agency relations were not governed by the legal system and that the relevant model is of complete information infinitely repeated game. (Greif (1993) discusses why an incomplete information model was ruled out and below I discuss how the unravelling problem was mitigated.) Specifically, it

indicates the relevance of an efficiency wage model with two particularly important features. Matching is not completely random but can be conditioned on the information available to the merchants, and sometime a merchant had to cease operating through an honest agent. Among the conclusions of the model is the existence of an (sub-game perfect) equilibrium in which each merchant employs an agent from a particular sub-set of the potential agents and all merchants cease operating through any agent who ever cheated.

This collective punishment is self-enforcing since the value of future relations with **all** the merchants keeps an agent honest. An agent who has cheated in the past and thus is not expected to be hired by merchants will not lose this value if caught cheating again. Thus, if a merchant nevertheless hires such an agent, the merchant has to pay a higher (efficiency) wage to keep the agent honest (relative to an agent who did cheat in the past). Each merchant is thus induced to hire only agents who are expected to be hired by others.

Acquiring and transmitting information during the late medieval period was costly, and hence the model should incorporate a merchant's decisions to acquire costly information. Since merchants gathered information by being a part of an informal information-sharing network, suppose that each merchant can either "Invest" or "Not Invest" in "getting attached" to such a network before the game begins, and his action is common knowledge. Investing entails cost each period in return for which the merchant learns the private histories of all the merchants who also Invested. Otherwise, he knows only his own history. Under the collectivist equilibrium history has value and thus merchants are motivated to Invest even if cheating does not occur on the equilibrium path.

A collective punishment can be effective only if an agent who cheated is restricted from utilizing the capital as profitably as the merchant he cheated. However, there is no historical reason to exogenously impose such a restriction. Yet, such a restriction can be generated endogenously under collective punishment. Particularly, an agent who also acts as a merchant (and invests his capital through agents) can be endogenously deterred from embezzling under collective punishment. When an agent also acts as a merchant, a strategy specifying non-punishment of agents who cheated a merchant who had cheated while acting as an agent is both self-enforcing and further reduces an agent's gain from cheating. It potentially enables hiring agents despite their ability to utilize the capital they embezzled in trade.

When agency relations are governed by a "coalition") a group of merchants utilizing the above strategy with respect to a particular group of agents) the collective punishment enables the employment of agents even when the relations between a specific merchant and agent are not expected to repeat. The gains from cooperation within the coalition (relative to hiring agents based on bilateral punishment) and the expectations concerning future hiring among the coalition's members ensures its "closeness." Coalition

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members are motivated to hire and to be hired only by other members, while non-members are discouraged from hiring the coalition's members.[20] Similarly, since membership in the coalition is valuable, an overlapping generations version of the model in which "sons" inherit their "fathers'" membership and support them in their old age, shows how the unraveling problem can be avoided.

The above theoretical discussion provides (some of the) conditions for and implications of governing agency relations by a coalition. Some of these implications are distinct from those generated by a bilateral efficiency wage model (Shapiro and Stiglitz, 1984) or a model of incomplete information about agents' type. For example, within the coalition agency relations are likely to be flexible) merchants would shift among agents and would hire agents even for a short period of time in cases of need. Merchants also prefer hiring other merchants as their agents, perhaps through forms of business associations that require agents' capital investment. Further, members of the coalition are likely to be segregated from other merchant and will not establish agency relations outside the coalition even if these relations) ignoring agency cost) are more profitable. Similarly, the sons of coalition members are likely to join the coalition.

Indeed, the *geniza* documents that reflect the operation of the Maghribis reveal the above conditions for and implications of governing agency relations by a coalition. It reflects a reciprocity based social and commercial information network with very flexible and not bilateral agency relations. There was no merchant or agent "class" among the Maghribis as merchants hired other merchants as their agents and utilized forms of business associations that required agents' investment. Furthermore, the Maghribis did not establish agency relations with other (Jewish or non-Jewish) traders even when these relations were considered by them to be very profitable. To begin operating in a new trade center, the Maghribis did not hire non-Maghribis but some of them immigrated to these centers and began providing agency relations. Finally, traders' sons indeed supported their fathers in old age and inherited membership in the coalition while family members were morally (but not legally) held responsible to each other.

Noticeably, these features that are observed among the Maghribis did not prevail among the Italian traders who operated (particularly from the twelfth century) in the same area as the Maghribis, trading in the same goods, and utilizing comparable naval technology. It seems that among them bilateral, rather than collective, punishment prevailed. (See further discussion below.)

In addition to the above indirect evidence for the governance of agency relations among the Maghribis by a coalition, the *geniza* contains direct evidence on various aspects of the coalition. Explicit statements reflect the expectations for a multilateral punishment, the economic nature of the expected

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[20] See, in particular, Greif (1994a).

punishment, the linkage between past conduct and future employment, the interest that all coalition members took in the relations between a specific agent and merchant, and so forth. Further, the *geniza* reflects the existence of a set of cultural rules of behavior that alleviated the need for comprehensive agency contracts and coordinated responses by indicating what constituted "cheating."

The factors leading to the selection of this particular strategy are also reflected in the historical records. They suggest that the multilateral punishment prevailed among the Maghribis due to a social process and cultural traits. The Maghribis were descendants of Jewish traders who left the increasingly politically insecure surroundings of Baghdad and emigrated to North Africa during the tenth century. Arguably, this emigration process, as well as their cultural background that emphasized collective responsibility, provided them with an initial social network for information transmission and made the collective punishment strategy a focal point. A particular social process and cultural background led to the governance of agency relations by a coalition, while the economic incentives generated by the coalition strengthened the Maghribis' distinct social identity. Indeed, the Maghribis retained their separate identity within the Jewish population until they were forced, for political reasons, to cease trading. This inter-relation between social identity and economic institution that governed agency relations suggests that the Maghribi traders' coalition did not necessarily have the efficient size. Since expectations regarding future employment and collective punishment were conditional on a particular ascribed social identity there was no mechanism for the coalition to adjust to its economically optimal size.

Clay (1994) conducted a similar study with respect to contract enforcement among long-distance American traders in Mexican California. In contrast to the situation among the Maghribis, her evidence suggests that the traders did not cease all their relations with an agent who cheated any of them. To comprehend this difference, Clay noted that an agent among these traders had a monopoly over credit transactions with members of a particular Mexican community. Since contract enforcement within each community was based on informal social sanctions, to sell on credit a trader had to settle in a community, marry locally, raise his children as Catholics, and speak Spanish at home. Furthermore, the small size of the Mexican communities implied that it was profitable for only one retailer to integrate in this way.

Clay integrated this feature in an infinitely repeated game with imperfect monitoring and found that a strategy calling for permanent and complete punishment of a trader who cheated in agency relations would have been Pareto inferior. Such a strategy barred all the traders from operating in the community where the cheater had a monopoly over contract enforcement. A strategy entailing a partial boycott for a particular period of time following a first cheating Pareto dominates a complete boycott strategy. The boycott is partial in the sense that it does not preclude transactions requiring the use of the cheater's local enforcement ability.

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A complete boycott follows only after a second act of cheating during a boycott. Direct and indirect evidence indicates that such a strategy was utilized by the traders. Hence, an environment different from that of the Maghribis led to a different, Pareto superior strategy suitable for the multi-dimensionality of traders' relations.

Contract enforcement among "anonymous" individuals: Two studies examined contract enforcement over time and space among "anonymous" individuals each of whom could avoid meeting the other again. In particular, contract enforcement over time was required at the Champagne Fairs in which, during the twelfth and the thirteenth centuries, much of the trade between northern and southern Europe was conducted. Milgrom, North and Weingast (1990) argued that in the large merchants' community that frequented the fairs, a reputation mechanism could not enable traders to commit to respect their obligations since large communities lacked the social networks required to make past actions known to all. Furthermore, the fairs' court could not directly impose its decision on traders after they left the fairs. Milgrom, North and Weingast suggested that a *Law Merchant* system, in which a court supplements a multilateral reputation mechanism, can ensure contract enforceability in such cases. Suppose that each pair of traders is matched only once and each trader knows only his own experience. Further assume that the court is capable only of verifying past actions and keeping records of traders who cheated in the past. Acquiring information and appealing to the court is costly for each merchant. Despite these costs, however, there exists an (symmetric sequential) equilibrium in this infinitely repeated complete information game in which cheating does not occur and merchants are induced to provide the court with the information required to support cooperation. It is the court's ability to activate the multilateral reputation mechanism by controlling information that provides the appropriate incentives. Furthermore, there exists an equilibrium in which the traders' threat to withdraw from future trade is sufficient to deter the court from abusing its information to extort money from the traders. To substantiate the historical relevance of the analysis, however, the paper only points out that the fairs' authorities controlled who was permitted into the fairgrounds.

Court and other historical records from western and southern Europe dating back to the mid twelfth century indicate the operation of another mechanism that enabled anonymous contracting over time and place. Traders applied a principle of community responsibility that linked the conduct of any trader and the obligations of each and every member of his community. For example, if a debtor from a specific community failed to appear at the place where he was supposed to meet his obligations, the lender could request the local court to confiscate the goods of any member of the debtor's community present at that locality. Those whose goods were confiscated could then seek a remedy from the original debtor. Traders used intra-community enforcement mechanisms to support inter-community exchange.

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Historians have considered this contract enforcement system to be "barbaric" since sometimes it led to "retaliation phases" in which trade between two communities ceased for a time following the accusation of cheating. Furthermore, some of the system's features) such as regulations aimed at increasing the cost of default to a lender, attempts of wealthy merchants from large communities to be exempt from the system, and its demise at the end of the thirteenth century - remain unexplained. Greif (1996a) utilized a repeated, imperfect monitoring game that captures the essence of the situation to comprehend these features as well as evaluating the pros and cons of the system.

The analysis indicates the rationale behind the costly "retaliation phases" as an on-the-equilibrium-path of play behavior required to maintain cooperation. They reflect asymmetric information between two local courts that reached different conclusions regarding the fulfillment or non-fulfillment of contractual obligations. The regulations that increased the cost of default to the lender and the attempt of wealthy merchants from large communities to be exempt from it, reflect the adverse selection problem the system entailed. Efficiency required that a lender be induced to verify the borrower's credit-worthiness, but the system implied that he also considered the future possibility of obtaining compensation from the borrower's community. Increasing the lender's cost of default mitigated this problem, while well-to-do members of wealthy communities were particularly interested in being exempted from the system since their community's wealth and size fostered the adverse selection problem. While they had the personal reputation required to borrow without community responsibility, their wealth enabled less credit-worthy members of their community to borrow. They were bearing the cost required to enable other members of their community to borrow. They preferred a community responsibility system from which they would be personally exempt. The model and historical evidence suggest that the decline of the system followed an increase in its cost (in terms of retaliation phases and the adverse selection problem). The cost increase was due to the rising number of trading communities, the increased wealth of some communities, and social and political integration that enabled one to falsify his community's membership.

The State: Emergence, Nature, and Functioning

Analyses of the European states enhance our understanding of the economic history of Europe. The European states were important economic decision makers and the competition among them is often invoked to account for the Rise of the Western World. Several studies utilized repetitive and repeated games with complete information and dynamic games with incomplete information to examine the inter-relations between economic factors and the origin and nature of the European state. They indicate the importance of viewing the state as a self-enforcing institution, the role of intra-state organizations in enhancing cooperation among

various elements within the state, and advance new interpretations of the parliamentary system. Finally, they indicate that there is a reason why wars may occur in a world with symmetric information and transferable utility.

The emergence and origin of the state: Among the most intriguing cases of states' formation in medieval Europe is that of the Italian city states. They were formed through (voluntary) contracts and many of them experienced very rapid economic growth from the eleventh to the fourteenth century. Genoa is a case in point: it was established (around 1096) for the explicit purpose of advancing the profit of its members, and indeed emerged from obscurity to become a commercial empire that stretched from the Black Sea and beyond to northern Europe.

Advancing the economic prosperity of Genoa required cooperation between Genoa's two dominant noble clans (and their political factions). They could militarily cooperate in raiding other political units or acquiring commercial rights from them, such as low customs or parts of ports which yield rent every period after their acquisition. The acquisition of such rights was the key to the city's long term economic prosperity. Yet, for cooperation to be forthcoming each clan had to expect to gain from it despite each clan's *ex post* ability to use its military power to challenge the other for its share in the gains. No clan made such attempt, however, from 1096 to 1164 but from 1164 to 1194 inter-clan warfare were frequent. Was inter-clan cooperation in acquiring rights prior to 1164 limited by the need to ensure the self-enforceability of the clans' contractual relations regarding the distribution of gains? Why did inter-clan warfare occur after 1169? Did the clans attempt to alter the rules of their game to enhance cooperation after 1164? These questions have been raised by historians but could not be addressed without an appropriate game theoretical formulation.

To address these questions, Greif (1994a, 1995) analyzed the situation as a repetitive game in which there is complete information regarding the clans' military strength but uncertainty regarding the outcome of a military conflict. The analysis indicates that self-enforceability may limit cooperation in the acquisition of rights. If the clans are at a mutual deterrence equilibrium with less than the efficient number of rights, it may not be in a clan's interest to cooperate in acquiring additional rights. In a mutual deterrence equilibrium with less than the efficient number of rights, neither clan challenges the other since the expected cost of the war and the cost implied by the possibility of defeat outweigh the expected gains from capturing the other clan's share. Additional rights may increase the expected benefit of a clan from challenging by more than the increase in the cost of potential defeat, leading to either military confrontation or forcing a clan to increase its investment in military ability. This "political cost" of acquiring rights implies that each clan may find it optimal to cooperate in acquiring less than the efficient number of rights.

The above analysis is incomplete since in the historical situation under consideration there is no

justification for taking the clans' share in the gain as exogenous. Can the clans necessarily overcome the economic inefficiency implied by the political cost by re-allocating the gains? Suppose that one clan finds it beneficial to challenge the other given its share in the gain and military strength. Although the game is of complete information there still may not exist any other Pareto superior equilibrium in which inter-clan war is prevented. It may not exist due to the uncertainty involved in military conflicts and the clans' ability to use their share in the gains to increase their military strength. Increasing the share in the gains of the clan that is about to challenge decreases the gains from a victory but increases the chance of winning. The other clan may thus be better off fighting while retaining the original allocation. Hence, the ability of Genoa's clans to cooperate could have been constrained by the extent to which the clans' relations were self-enforcing.

But was it historically the case that the need to ensure self-enforceability of inter-clan relations constrained inter-clan economic cooperation? Under the assumption that this was indeed the case, the model yields various predictions, such as the time path of cooperation in raids and acquiring rights, investment in military strength, and responses (including inter-clan military confrontation) to various exogenous changes. These predictions are confirmed by the historical records. It was only in 1194 that a process of learning and severe external threat to Genoa motivated the clans to establish a self-enforcing organization known as a *podestà* (that is, a "power"). It altered the rules of the political game in Genoa to increase the parameters' set (including the number of rights) for which inter-clan cooperation could have been achieved as a mutual deterrence equilibrium outcome. Furthermore, the podesteria coordinated on such an equilibrium. Essentially, the *podestà* was a non-Genoese hired for a year to govern Genoa, supported by his own military contingent. The *podesteria's* self-enforcing regulations were such that the *podestà* could commit to use his military power (only) against any clan attempting to militarily challenge another. It was under the *podesteria*, which formally lasted about 150 years, that Genoa reached its political and commercial apex. Understanding Genoa's commercial rise requires comprehending its political foundations.

Green (1993) analyzed the emergence of the parliamentary government of England during the 13th century which arguably contributed to England's subsequent growth. The analysis supports the conjecture that a shift to parliamentary government reflects benefit to costly communication of private information. The existing balance-of-power theory that views changes in governmental systems as indicative of changes in the technology of capturing or defending property, fails to give a rationale for a central provision in the Magna Carta (1215). Instead of requesting tax cuts the English barons insisted that the King should request their consent for new taxes. Green argues that this request reflects the benefit of communication and exchange between the parties.

The loss of the English Crown's possessions in France shortly before 1215 and the increased

complication of European politics augmented the threat of an external invasion of England and implied that the King had better information regarding such an invasion. To see why such an external threat and private information might make a political system based on communication Pareto optimal, Green analyzed the following model. Consider a one period game in which a ruler can always expropriate (at most) half of the subject's crop. There is some probability of an external threat to the whole crop which the ruler can successfully confront by (a) taking a costly action, and then (b) confronting the threat (without any additional cost). If there is no threat the ruler prefers half the crop, over taking the costly action. If there is a threat the ruler prefers taking the action if provided with two-thirds of the crop rather than not taking the action and getting no share at all. The subject can provide the ruler with two-thirds of the crop between (a) and (b). Whether the external threat is about to materialize or not is the ruler's private information. In this model there is a Bayesian Nash equilibrium in which the ruler communicates that the external threat has materialized by taking the costly action and the subject provides him with two-thirds of the crop. Despite the costly communication, this equilibrium Pareto dominates the equilibria in which there is no communication. Hence, a shift to parliamentary government may reflect the benefit of costly communication.

Committing to Respect Property Rights: The five bankruptcies of the Spanish Crown (1557, 1575, 1596, 1607, and 1627) during the height of Spanish economic and political dominance are often used to demonstrate the limitations of a pre-modern public finance system (Cameron, 1993, p. 137). The rulers' inability to commit to the property rights of their lenders hindered their ability to borrow. In a detailed historical and game theoretical analysis, Conklin (1995, 1996) advanced a different interpretation of these bankruptcies as reflecting a routine re-alignment of the King's finances. In other words, they do not reflect the failure of a system but of its operation. Historically, these bankruptcies were not a wholesale repudiation of obligations to creditors. They were initiated by the Genoese, the King's foreign lenders, who ceased providing him with credit. In response, the King ceased paying the Genoese and negotiated a partial re-payment of his debt to them with obligations that they could sell to Spain's elite, namely, the King's local lenders.[21] After this realignment, the Genoese resumed lending.

To comprehend this, Conklin utilized a repeated game with state variables, an important component of which is that the King "cares" about the welfare of his Spanish lenders. The justification for this specification is the King's dependency on these elite Spaniards for tax collection, administration, and military operations. Solving for a pareto optimal sub-game perfect equilibrium using a computer algorithm indicated that financial re-alignment should have occurred when the King reached the limit of his ability to commit to

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[21] In the process the Genoese had to bear some losses.

the Genoese. Shifting some of this debt to his elite to whom he could commit was a pre-requisite for additional lending. This interpretation gains additional support by shedding light on various aspects of the situation, such as the particularities of the tax collection system and the King's willingness to prey on the wealth of particular Spaniards while continuing to pay his local debt.

Within States:

The analyses of historical market structures (namely number and relative size of firms within an industry), financial systems, legal systems, and development have been facilitated by game theory. At the same time, these analyses utilized historical data sets that enabled the examination of game theoretical industrial organization models, confirmed game theoretical predictions regarding the relations between rules and behavior, suggested the role of banks and the distribution of rent in initiating a move from one equilibrium to another, and inspired new game theoretical model of financial and market structure.

Market Structure and Conduct: Business records from the period prior and following the Sherman Act provide unique data sets to empirically examine the relations between strategic behavior and market structures. Their analyses substantiated the importance of predation and reputation in influencing market structures, enabled empirical examination of tacit collusion's models, indicated the limitation of using only indirect (econometric) evidence in examining inter-firm interactions, and suggested that existing models of market structures are deficient in ignoring the multi-dimensionality of inter-firm interactions.

Burns (1986) examined the role that a reputation for predatory pricing played in the emergence of the tobacco trust between 1891 and 1906. An econometric analysis of the purchases of 43 rival firms by the old American Tobacco Company indicates that alleged predation significantly lowered the acquisition costs both for asserted victims and, through reputation effect, for competitors that sold out peacefully. Similarly, Gorton (1996) examined the formation and implication of reputation in the Free Banking era (1838-60) during which new banks could enter the market and issue notes. Economic historians noticed, but found difficult to explain, that "wildcat" ("fly by night") banking was not a pervasive problem during this period. The Diamond (1989) incomplete information model suggests that if some banks were wild cats, some were not, and some could have chosen whether to be wild cats or not. A process of reputation formation may have deterred banks from choosing to become wildcats. Due to information asymmetry, initially all banks face high discount rates, but following the default of the wild cats the discount rate declines due to the reputation acquired by the surviving firms. This decline, in turn, further motivates firms that can choose not to be wildcats. Gorton conducted an econometric analysis of various aspects of these conjectures, (particularly whether new banks' notes were discounted more and whether this discount depended on the institutional

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environment) that confirmed the importance of reputation in preventing wild cat operations.[22]

Weiman and Levin (1994) combined direct and indirect (econometric) evidence to examine the development and implication of the strategy employed by the Southern Bell Telephone Company to acquire a monopoly position between 1894 and 1912. In sharp contrast to the usual assumption in Industrial Organization, the strategic variable that enabled it to become a monopoly was not only price but also investment in toll lines ahead of demand, isolating independents in smaller areas, and influencing regulations by increasing the cost of competition to the users. Similarly, Gabel (1994) substantiated that between 1894 and 1910 AT&T acquired control over the telephone industry through predatory pricing. Despite its short term cost, price reduction enabled AT&T to deter entry and to cheaply buy the property of independents. This strategy was facilitated by rate regulations and capital market imperfection that prevented independents from entering on a large scale.

In a classical study, Porter (1983) examined collusion of a railroad cartel (the "Joint Executive Committee") established in 1789 to set prices for transport between Chicago and the East Coast. Using data from 1880 to 1886 the study tested and could not reject the relevance of Green and Porter's (1984) theory of collusion with imperfect monitoring and demand uncertainty. (The alternative was that price movements reflect exogenous shifts in demand and cost functions.) According to the Green and Porter theory, price wars occur on the equilibrium path due to the inability of firms to distinguish between shift in demand and a firm's defection. A sufficiently low price triggers a price war of some finite length, and although all firms realize that deviation did not occur, punishment is required to retain collusion. Similar results were obtained by Ellison (1994), who confronted the Green and Porter model with that of Rotemberg and Saloner (1986) in which price wars never transpire and on-the-path prices exhibit a counter-cyclical pattern.

The Green and Porter model also provides the theoretical framework utilized by Levenstein (1994, 1996a, 1966b) to examine collusion in the pre-WWI US bromine industry. An econometric analysis could not reject the Green and Porter model, indicating that price wars stabilized collusion. Yet, Levenstein (1996a) claimed that this conclusion is misleading. Using ample direct evidence, Levenstein substantiated that only a few wars stabilized collusion in the Green and Porter sense and these were short and mild. Long and severe price wars were either bargaining instruments aimed at influencing the distribution from collusion, or a profitable deviation from collusive behavior made possible by asymmetric technological changes. Finally, similar to the studies discussed above, her paper casts doubt on the empirical relevance of the

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[22] See also Ramseyer's (1991) study of the relations between credible commitment and contractual relations in the prostitution industry in Imperial Japan.

strategic models of collusion which assume that price is the only strategic variable. In the bromine industry, collusion of firms was facilitated by altering the industry's information structure and marketing system (Levenstein, 1996b).

Financial Systems and development: The nature and role of financial intermediaries that functioned prior to the rise of banks and securities markets have hardly been examined, limiting our understanding of pre-modern financial markets. Furthermore, the relations between development and distinct financial systems (differentiated by the nature and relative importance of banks and securities markets) have been examined by economic historians. Yet, comprehension of the origin and implications of different systems has so far been elusive (Mokyr, 1985, p. 37). Only recently has the integration of game theory and historical research facilitated the analysis of alternative intermediaries, enabled exploring the origins and implications of diverse financial systems, and suggested a so far unexamined role for banks in coordinating development.

Hoffman, Postel-Vinay, and Rosenthal (1994) utilized a repeated game model and a unique data set from Paris (1751), to examine theoretically and econometrically the operation of a credit system as an alternative to banks and security markets. In Old Regime France, notaries had property rights over the records of any transaction they registered. Hence, they had a monopoly over the information required for screening and matching potential borrowers and lenders. Their ability to provide credit market intermediation, however, could have been hindered by a "lock-in" effect. Unless they were able to commit not to exploit their monopoly power, potential participants in the credit market would have been deterred from approaching them. A game theoretical formulation of this problem revealed that it could have been mitigated by an equilibrium in which notaries shared information with each other to reduce (each notary's) monopoly power over his clients. Indeed, the data confirms the behavior associated with this equilibrium.

There is a consensus among economic historians that different financial and industrial systems prevailed in the first and second main European countries to industrialize, namely, England and Germany.[23] English firms were relatively small and tended to be financed through tradeable bonds and arms-length lending. The German firms, however, were large and tended to be financed by loans from particular banks which closely monitored them. Motivated by this difference, Baliga and Polak (1995) attempted to explore its rationale and origins using a dynamic game capturing the moral hazard problem inherent in industrial loans. Entrepreneurs would provide only second-best effort levels in the absence of monitoring, while costly monitoring induces more effort. Monitoring exhibits internal economies of scale while markets for tradeable loans exhibit external economies of scale.

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[23] Some recent papers doubt this difference, see Fohlin (1994) and Kinghorn and Nye (1996).

The analysis provides the foundation for potentially beneficial future empirical analysis. It leads to comparative statics predictions regarding the relations between exogenous factors (such as base interest rates, firm size, and lenders' bargaining power) and the entrepreneurs' choice of financial arrangements. Furthermore, it indicates the possible impact of the entrepreneurs' wealth and the market in government's securities on the efficiency and selection of financial arrangements. When the analysis is further extended to an entry game in which entrepreneurs choose a firm's size and banks choose whether to acquire monitoring ability, multiple equilibria exist indicating a possible rationale for the emergence and persistence of different systems.

The role of banks in coordinating development is suggested by the "big-push" theory of economic development (Murphy et al. 1989). When externalities make investment profitable only if enough firms invest at the same time, failure to coordinate on such a simultaneous investment may lead to an "underdevelopment trap." Inspired by this model and the positive historical correlation between rapid industrialization and large banks with some market power or large equity holdings in industrial firms, Da Rin and Hellmann (1996) developed a model of the role of banks in coordinating a transition to an equilibrium in which firms invest. Utilizing a dynamic game with complete information they suggested that this positive correlation reflects the role of large banks in initiating a move from one equilibrium to another. A necessary condition for banks to coordinate industrialization is that at least one bank (or coordinated group of banks) is large enough to initiate a big push by subsidizing the investment of a critical mass of firms to induce them to invest. A bank's monopoly power or capital investment is required, however, to motivate that bank to coordinate by enabling it to benefit from the industrialization it triggered.

Law, Development, and Labor Relations:[24] Game theoretical models were used to evaluate the impact of legal rules and procedures on development and labor relations in various historical episodes. Rosenthal (1992) established that despite the efficiency of several potential drainage and irrigation projects in France from 1700 to 1860, they were not carried out. In sharp contrast, efficient projects were undertaken in England during this period, as well as in France after the French Revolution. The efficient projects were not carried out since the village which had some de facto or de jure property rights over the land, and the lord who wanted to initiate the project, failed to reach an agreement regarding the distribution of the gains. Rosenthal conjectured that the distinct legal features of Old Regime France accounted for this failure.

To demonstrate that the legal features of the Old Regime could have inhibited reaching an agreement, Rosenthal utilized a dynamic incomplete information game. Central to the model is asymmetric information

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[24] See also Milgrom, et al. (1990) and Greif (1996a) discussed above.

regarding the legal validity of the village's rights over the land and the "burden of proof" rule, namely, whether the property rights will be assigned to the lord or the village if neither party is able to establish de jura rights over the land. The analysis indicates that legal prohibition on out-of-court settlements, the burden of proof rule that favored the village, and the high cost of using the legal system increased the number of efficient projects that lords would find unprofitable to initiate. All these features of the legal system prevailed in Old Regime France but not in England or post revolutionary France.

Treble (1990) examined the impact of legal regulations on wage negotiations in the British coal industry from 1893-1914. These negotiations were conducted in "conciliation boards," and in cases of disagreement an arbitrator had to be used. The number of appeals made to arbitrators differed greatly among coal fields, and ranged from as low as 11 percent to as high as 56 percent (per number of negotiations). The economic historians' traditional explanation of these differences is that they reflected differences in the negotiators' personalities. Treble, however, modeled the bargaining process as a game which (unlike many other bargaining models, such as Farber 1980) generated predictions regarding the frequency of appeal to arbitration. Treble's analysis predicts that because delay in reaching an agreement has a strategic value, the more the constitution of a particular conciliation board permitted delay without arbitration, the less arbitration would be used. When this hypothesis (and the alternatives that appeal depended on personalities or reflected asymmetric information regarding the arbitrator's preference (Crawford, 1982b)), was placed under econometric analysis it could not be rejected.

Between States

Utilizing repeated and static games studies that integrate game theoretical and historical analyses have indicated the importance of non-market institutions in influencing the historical process through which long-distance trade grew and the empirical relevance of the ideas behind renegotiation proof equilibrium.[25] They have also lent support to the New International Trade Theory, indicated the implications of intra-firm incentive structure on inter-firm strategic interaction, how strategic international relations impact domestic economic policy, how cooperation can evolve, and the relations between equilibrium selection and credible, public communication.

International Trade: Greif, Milgrom, and Weingast (1994) examined the operation and implications of an institution that enabled rulers during the late medieval period to commit to the security of alien traders'

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[25] The discussion above regarding agency relations and anonymous trade also relate to the institutions and long-distance trade. For elaboration on insights provided by game theoretical analyses of long-distance trade in history, see Greif (1992).

property rights. Having a local monopoly over coercive power, any medieval ruler faced the temptation to abuse the property of alien merchants who frequented his realm. Without an institution enabling a ruler to commit *ex ante* to secure their rights, alien merchants would not come to trade.

Since trade relationships were expected to repeat, one may conjecture that a *bilateral reputation mechanism* (in which a merchant whose rights were abused ceased trading), or an uncoordinated *multilateral reputation mechanism* (in which a subgroup larger than the one that was abused ceased trading), could surmount this commitment problem. This conjecture, however, is misleading. Although each of these mechanisms can support some level of trade, neither can support the *efficient level of trade* (independently from the distribution of the gains from trade and the ruler's discount factor). The bilateral reputation mechanism fails because, at the efficient level of trade, the value of future trade of the "*marginal*" traders to the ruler is zero, and hence the ruler is tempted to abuse their rights. In a world fraught with information asymmetries, slow communication, and the possible different interpretations of facts, the multilateral reputation mechanism is prone to fail for a similar reason. Hence, theoretically, a multilateral reputation mechanism can potentially overcome the commitment problem only when the merchants have some organization to coordinate their actions. Such a coordinating organization implies the existence of a Markov perfect equilibrium in which traders come to trade (at the efficient level) as long as a boycott has never been announced, but none of them come to trade if one has been announced. The ruler respects the merchants' rights as long as a boycott has never been announced, but abuses their rights otherwise. When a coordinating institution exists, trade may plausibly expand to its efficient level.

Although the strategy just described makes a perfect equilibrium, the theory in this form remains unconvincing considering the ideas behind renegotiation proof equilibrium. According to the above equilibrium strategies, when a coordinating institution declares an embargo merchants are deterred from disregarding it because they expect the ruler to abuse the violators' property rights. But are these expectations reasonable? Why would a ruler not *encourage* embargo-breakers rather than punish them? Encouragement is potentially credible since during an effective embargo the volume of trade shrinks and the value of the marginal trader increases; it is then possible for bilateral reputation mechanisms to become effective. This possibility limits the potential severity of an embargo and potentially hinders the ability of any coordinating organization to support efficient trade. In such cases, the efficient level of trade can be achieved when a multilateral reputation mechanism is supplemented by an organization with the ability to coordinate responses <u>and</u> ensure the traders' *compliance* with boycott decisions.

Direct and indirect historical evidence indicates that during the Commercial Revolution an institution with these attributes) the *merchant gild*) emerged and supported trade expansion and market integration.

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Merchant gilds exhibited a range of administrative forms) from a subdivision of a city administration, such as that of the Italian city-states, to an inter-city organization, such as the German Hansa. Yet, their functions were the same: to ensure the coordination and internal enforcement required to make the threat of collective action credible. The nature of these gilds and the date of their emergence reflects historical as well as environmental factors. In Italy, for example, each city was large enough to ensure that its merchants were not "marginal" and their legal authorities ensured their merchants' compliance with the gilds' decisions. In contrast, the relatively small German cities had to organize themselves as one gild through a lengthy process to be able to inflict an effective boycott.

Irwin (1991) utilized a game theoretical model to examine the competition between the English East India Company and the Dutch United East India Company during the early seventeenth century. The Dutch were able to achieve dominance in the trade in pepper brought from the Spice Islands of Indonesia although both companies had similar costs and sold the pepper for the same price in the European market. To comprehend the sources of the Dutch's dominance, Irwin argued that the nature of the competition in the pepper market resembles Brander and Spencer's (1985) model of duopolistic competition in which two companies exporting a single good are engaged in a one period Cournot (quantity) competition. The English and Dutch companies competed mainly in the market for pepper and both were state monopolies whose charters could have been invoked (de jura or de facto) in any period. If this indeed was the situation, Brander and Spencer's analysis indicates that any trade policy shifting one company's reaction function outward increases its Nash equilibrium profit while reducing that of the other. The policy that seems to have shifted the Dutch company's reaction function was instituted through its charter. It specified that its managers' wages should be a function of the company's profit <u>and</u> volume of trade thereby shifting the company's reaction function outward (as in Fershtman and Judd, 1987).[26] Intra-firm incentive structure influenced inter-firm competition.

International Relations: Maurer (1992) conducted a case study of the Anglo-German naval arms race from 1912 to 1914, providing an interesting example of actual equilibrium selection and the "evolution of cooperation" (Axelrod, 1984). During this period the arms race resembled a repeated prisoners' dilemma game as both countries recognized the high cost it entailed. Some informal cooperation had been achieved when, in 1912, the first lord of Britain's Admiralty, Winston Churchill, publicly announced a tit-for-tat strategy. Beyond the number of battleships already approved for building in Germany and Britain, Britain

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[26] Irwin argues that this result supports the view of mercantilism as a strategic trade policy. Arcand and Brezis (1993) take a similar stand.

would build two battleships for each additional German battleship. The Germans adopted their best response of not producing additional battleships after testing the credibility of the English's announcement. Thus the arms race and public spending were diverted in other directions, such as construction of destroyers, the build-up of ground troops, and enhancing the battleships' features. Negotiation over a formal and broader arms control agreement failed, however, particularly because both parties were concerned that the discussion would worsen their relations by raising the contentious security issues reflected in the naval competition and its link to the wider issue of the European balance of power.

Culture, Institutions, and the Organization of Society

A long tradition in economic history argues that culture and institutions (namely, the non-technologically determined constraints on behavior) impact economic performance and growth.[27] The study of the inter-relations between institutions and culture, however, was hindered by the lack of appropriate theoretical framework. This limited the ability to address questions that seemed to be at the heart of developmental failures: Why do societies evolve along distinct institutional trajectories? Why do societies fail to adopt the institutional structures of more economically successful ones?

Greif (1994a, 1996b) integrated game theoretical and sociological concepts to conduct a comparative historical analysis of the relations between culture and institutions. The analysis considers the cultural factors that led two pre-modern traders' societies) the Maghribis from the Muslim world and the Genoese from the Latin world) to evolve along distinct institutional trajectories. It builds on a distinction between two elements of institutions) expectations and organizations) which is made possible by game theory. A player's expectations about the behavior of others are part of the non-technologically determined constraints that player's faces. Organizations (such as the credit bureau, the court of law, or the firm) can potentially constrain behavior as well by changing the information available to players, changing payoffs associated with certain actions, or introducing another player (the organization itself). Clearly, organizations can be either exogenous or endogenous to the analysis (as discussed in Greif, 1996c). When they are endogenous their "introduction" means that they were transformed from being off-the-path-of-play (recognized or unrecognized) possibilities to an on-the-path-of-play reality. Culture can potentially impact institutions since culturally determined expectations influence equilibrium selection, and hence also the impact of existing organizations and the incentives to introduce particular organizations.

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[27] E.g., North (1981). For an elaboration on recent developments in the study of institutions in economic history, see Greif (1996c).

Indeed, as mentioned above, distinct cultural heritages and social processes among the Maghribis and the Genoese seem to have led to a selection of distinct equilibria in the merchant-agent game. The Maghribis reached a "collectivist equilibrium" that entailed a collective punishment while the Genoese reached an "individualist equilibrium" that entailed bilateral punishment. What is more surprising, however, is that a game theoretical and empirical analysis indicates that once the distinct expectations associated with these strategies were formed with respect to agency relations they became "cultural beliefs" and transcended the original game in which they had been formed. They transcended the original game in the sense that they influenced subsequent responses to exogenous changes in the rules of the game and the process of organizational development. In other words, they became a cultural element that linked games.

Classical game theory does not say much about such inter-game linkages: Actions to be taken following an expected change in the rules of the game are a part of the (initial) equilibrium strategy combination, while an equilibrium that would be selected following an unexpected change in the rules of the game has no relation with the equilibrium that prevailed prior to the change. Yet, comparing both groups' responses to exogenous changes indicates that the equilibria selected following unexpected changes in the rules of the game had predictable relations to the equilibria that prevailed prior to the change.[28] Cultural beliefs provided the initial conditions in a dynamic adjustment process through which the new equilibria were reached. Furthermore, the initial equilibria were related in a predictable manner to subsequently historical organizational innovations. Differences in organizational innovations among the two groups (with respect to organizations such as the gild, court, the family firm, or the bill of lading) can be consistently accounted for as reflecting incentives generated by the expectations that following the organizational change, the original cultural beliefs would still prevail. (Yet, the theory can not account for the timing of these organizational changes. It took a long period of time to introduce an organization despite the incentives and possibility of earlier introduction.)

If cultural beliefs link games, they imply organizational path dependence and limit the inter-society transfer of organizations, since the implications of adopting a particular organization depend on the prevailing cultural beliefs. This organizational path dependence and the cultural beliefs' impact on responses to exogenous changes indicate the rationale for the emergence of distinct societal organizations, namely, distinct economic, social, legal, and moral enforcement institutions, together with the associated social constructs, information transmission and coordination mechanisms. Interestingly, the distinct societal organization found among the Maghribis and Genoese in the late medieval period resembles those found by

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[28] Similar results emerged in experiments. See Camerer and Knez (1996).

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social psychologists which differentiate contemporary developing and developed economies. This suggests the historical importance of distinct cultures and their impact on societal organizations and economic development.

Conclusions:

Although all the above studies integrated game theoretical and economic history analyses, they differ in their objective, methodology, the weight placed on theory versus history, and, no doubt, their quality. Yet, they forcefully indicate the potential contribution of such integration to economic history, game theory, and economics. Game theory has expanded the domain of economic history by enabling examining important issues that could not be adequately addressed using a non-strategic framework. It enabled examination of diverse issues such as contract enforcement in medieval trade, the economic implications of legal proceedings in Old Regime France, trade rivalry between the Dutch Republic and England, bargaining in England's coal mines, and the process through which the industrial structure emerged in the US. It provided, among other insights, new interpretations of the nature and economic implications of merchant gilds, the Glorious Revolution, the role of banks in development, the structures of industries, and the free-banking era.

More generally, these studies indicate the promise of integrating game theory and economic history in advancing our understanding of a variety of issues whose study requires strategic analysis. Among them are the nature and implications of the institutional foundations of markets, the legal system, the inter-relations between culture and institutions, the link between the potential use of violence and economic outcomes, the impact of strategic factors on market structures, and the economic implications of organizations for coordination and information transmission.[29] Further, although all the above studies used equilibrium analysis, they illuminated sources and implications of changes and path dependence. Incentives and expectations on and off-the-equilibrium-path indicate the rationale behind the absence or occurrence of changes, while institutional path dependence was found, for example, to be due to acquired knowledge and information, economies of scale and scope associated with existing organizations or technology, coordination failure, distributional issues, capital market imperfections, and culture.[30]

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[29] Greif (1996c) elaborated on recent developments in the study of institutions in economic history.

[30] On path dependence and institutions, see North (1990) (who emphasizes economics of scale and scope, network externalities, and a subjective view of the world) and David (1994) (who emphasizes conventions, information channels and codes as "sunk" organizational capital, interrelatedness, complementarities and precedents). E.g., knowledge: Hoffman et al. (1994); Scale, scope, coordination, and culture: Greif (1994a); Weiman and Levin (1994). Distribution: Rosenthal (1992). For a recent discussions of institutional path dependence, see Greif (1996c, 1997).

Perhaps the most important contribution to game theory of integrating historical and game theoretical analyses is that this integration provides additional support for the importance of examining strategic situations and the empirical usefulness of game theory. Indeed, history provides a unusual laboratory in which to examine the empirical relevance of game theory since it contains unique data sets regarding strategic situations and the relations between rules and outcomes. Interestingly, infinitely repeated games that have been considered by many as indicating the empirical irrelevance of game theory because they usually exhibit multiple equilibrium, were found to be particularly useful for empirical analysis. Further, the studies discussed above also demonstrate the limitations of the theory and suggest directions for future development. For example, they indicate (in the spirit of Schelling (1960) and Lewis (1969)) that understanding equilibrium selection may require better comprehension of the relations between selection and factors outside (the current formulation) of games, such as culture. Similarly, the study of organizations and organizational path-dependence indicates the importance of considering the process through which the rules of the game are determined and the implications of organizations on the equilibrium set and equilibrium selection.

Last, but not least, economic history analyses utilizing game theory have enhanced our knowledge regarding issues central to economics, such as the nature and origin of institutions, the strategic determinants of industry structures and trade expansion, collusion, property rights, the economic implications of political institutions, labor relations, and the operation of capital markets. Hence, it provides an additional dimension to the long and productive collaboration between economic history and economics. Furthermore, these analyses indicate the need for and the benefit of combining theoretical and empirical research that transcends the boundaries of history, economics, political science, and sociology.

The integration of historical and game theoretical analyses is still in its infancy. Yet, it seems to have already reaffirmed McCloskey's (1976) claims regarding the benefits of the interactions between economic history and economics in general. It has provided an improved set of facts to evaluate current theories, suggested theoretical advances, and expanded our economic knowledge.

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