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AT YALE UNIVERSITY

Box 2125, Yale Station
New Haven, Connecticut 06520

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THE THEORY OF MONEY AND FINANCIAL INSTITUTIONS

by

Martin Shubik

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Abstract

A sketch of a game theoretic approach to the Theory of Money and Financial Institutions is presented in a nontechnical, nonmathematical manner. The detailed argument and specifics are presented in previous articles and in a forthcoming book.

THE THEORY OF MONEY AND FINANCIAL INSTITUTIONS

Martin Shubik

Rational Behavior: Greed, modified by sloth, constrained by formless fear and justified, *ex post*, by rationalization.

The Basic Role of Money and the Financial Structure

The theory of money and financial institutions addresses the processes that are used to aggregate, disaggregate, and evaluate information in the economic control mechanisms of a mass, modern, highly anonymous society.

Locally, over short periods of time the motion of parts of the economic system appears to conform to the microeconomist's ideas of "economic man." On a larger stage many different macroeconomic models offer partial insight to not necessarily pure economic behavior (whatever that is).

Globally the economic system is open and evolutionary and is merely a part of the evolving politico-economic system in which it is embedded. This in turn must be viewed in the context of society, history and biology.

The resolutely rationalistic viewpoint of "the rational economic agent" acting more or less without context can be reinterpreted, in context. Society and the institutions of society are in a state of constant evolution and much of that evolution is driven by the economic and political agents of the society. The economic agents, in particular, for the most part take the short term environment as given, but their apparently rational local optimization is an important factor in changing the environment in the longer term.

The three key instruments that permit the economy to run as a loosely coupled system are fiat money, credit and the default, bankruptcy and reorganization laws.

Fiat money in its purest form is a society's symbolic substitute for trust. In the ideal mass market small agent competitive economy without inflation the money serves its role as manna or linearly separable utility or soma pills. In the actual world around us, at least in a stable economy, in the short run money may be

accepted in anonymous trade with no need for elaborate data processing or character evaluation required between the agents. It fulfills the old New England adage: "In God we trust, all others pay cash."

For various technical efficiency reasons the money supply in a society may need to be varied over time. In the course of the evolution of the monetary mechanism, commodity money which, to some extent may provide its own guarantee of worth, was replaced by fiat, basically because there is physically no satisfactory commodity with all of the appropriate properties to use as a valuable substitute for trust. In particular there is no physical commodity in sufficient supply that has a high enough value to cover world trade.

Banking

An imperfect substitute for fiat or commodity money is credit. Credit involves either a direct bilateral relationship between the ultimate creditor and the ultimate debtor or a chain of relationships involving financial intermediaries acting as principals or agents.

As the top banks in many countries tend to be long lived and well known, their credit, usually in the form of deposit accounts, or historically in the form of bank notes (not unlike the notes of merchants who became merchant bankers) "circulates as money." By this expression we mean it is accepted in transactions as though it were a perfect or nearly perfect substitute for the trust pills, or surrogate for trust called fiat money, supplied by the government. In stark contrast the paper of an anonymous debtor turning up at the bank looking for a loan, does not circulate with ease.

The bank's paper and the country's paper are not anonymous. On the contrary they are accepted by anonymous individuals in exchange because the country is known, trusted and feared and hopefully the bank is known and has a reputation for honoring its debts.

When the bank makes a loan to an individual, for the most part it exchanges its debt for the debt of the individual. But because of the preexisting information, evaluation and trust conditions the bank's debt is accepted as a substitute for government money and the government money is the ultimate surrogate for trust. With the growth of population, custom, law, technology and the nation state, a symbiotic relationship between governments and commercial banks has evolved where the banks together with the central government vary the money supply. This can be done because of the close relationship in transactions

function between bank short term debt or deposits and fiat money. This debt can be regarded as a near money and counted as part of the money supply. As the commercial banks help to perform the public function of varying the money supply, it is important that their money be as good as cash. Hence there has grown up in most countries a special body of law, government supervision, guarantees and custom, designed to signal to the public at large that the credit of these institutions is as good as the government's money, and that the customer (at least in theory) does not need to indulge in detailed data processing and evaluation of the viability of the institution.

The bank when it makes its loan, or exchanges debt with the individual does not have the luxury of indulging in an anonymous exchange, unless the individual has assets clearly worth more, under most plausible circumstances, than the debt he is contracting.

There is an old banking adage that is not merely a good catch phrase but also it contains several of the essentials of a good theory of banking. In making loans the "three-c's count". They are character, competence and collateral. The first two of the three c's are high information and evaluation items, the third protects the borrower against bad evaluation. If an individual holds a portfolio consisting of the Dow Jones Average basket of shares and it is worth five times the amount of his six month loan, the security available is sufficiently large that if the shares are locked in the bank's vault during the time of the loan (and their ownership has been verified) the bank need not have a highly detailed assessment of character and competence.[1]

But for many loans, reputation, character evaluation and competence evaluation are of considerable importance. Good faith is frequently not enough; ability helps. Possibly the best test of the skills of a banker is the performance of his loans secured by his evaluation of character and competence rather than his performance with highly collateralized loans.

The economy of a world with billions of individuals requires a division of labor that stretches to providing credit evaluations for individuals who do not have the time or ability to provide the evaluations themselves, yet whose businesses depend on dealing with, but not needing to trust strangers. Thus the growth of the credit card together with a real time communication system represents part of the new

[1]Although even under these circumstances a good banker should understand and favorably assess the purposes of the loan.

industrial revolution, where the roadside restaurant owner can stick to worrying about his cooking. All he needs to do is to run a piece of plastic through a machine in a few seconds to find out if the stranger in front of him can have credit extended.

Bankruptcy and Default

Possibly the key item which links locally optimizing economic behavior to the political economy evolving as a whole is the relationship between credit, money and bankruptcy, default and reorganization.

In an economy which has fiat money, uses credit and has some form of uncertainty present, it is almost always certain that the economy can attain a state where someone who has borrowed is not able to repay his loans. It is customary (but logically not strictly necessary) that loans are denominated in terms of the lawful money of the country. In order to well define an economic process, the society must provide rules or laws which specify what happens when an individual defaults. This is done by the bankruptcy, default and reorganization laws which link the unpaid debt denominated in money to economic and noneconomic sanctions.

In essence the bankruptcy, default and reorganization laws of a society are a public good of that society. When an individual or corporation goes bankrupt the losses are divided in some manner among many agents of the society. The severity or leniency of the laws indicates a society's willingness or lack of willingness to encourage risk-taking and to share in the costs of failure. This is traded off against the society sharing, at least indirectly, in the fruits of success. Thus the financing of a new industry or process has its downside and upside for society as a whole, as well as the entrepreneur who borrows. An analogy with an evolutionary biological process is that the bankruptcy and reorganization rules control the mutation rate of the economy. The more lenient the rules, the more willing will entrepreneurs be to take risks. But a risk that fails is like a mutation that fails. The resources did not achieve a new viable form, but must be absorbed by the process, whereas the successful program may yield viable new products or industries, and the mutation succeeds.

The Economy and Context

The economy is an evolutionary system, driven by a myriad of locally acting agents whose behavior, can be described as context limited constrained optimization. The word "context" reminds us that no matter how well we may manipulate probability theory, updating our priors, our original views of the environment are of critical importance to behavior. Yet where these priors came from is hardly discussed, even though individuals are socialized by the society into which they are born. The word "constrained" modifies optimization to remind us that although we do not yet understand time, decisionmaking takes time and all humans find that their decisionmaking is often time constrained.

Although writings on economics are clearly present prior to Adam Smith, the general awareness of political economy (tied in with moral philosophy) as a separate subject of enquiry, in essence, dates from around the late eighteenth century. The explosion in world population, communication and utilization of energy sources begins less than a century before the general recognition of political economy.

Since that time the numbers of individuals devoted to some variant of economics as a profession has proliferated, as have the specialized branches of enquiry.

In the last sixty years, what was, for the most part, political economy, split into micro and macroeconomics. The macroeconomists, in general, have been concerned with here and now. They have been concerned with advice giving and how to solve many of the pressing operational economic and socio-economic problems of a modern nation state. Government, money and financial institutions are taken as givens. The niceties of mysterious unseen objects such as utility functions which exist in the microeconomist's Pantheon only occasionally bother the macroeconomists concerned with items such as inflation and unemployment.

While the macroeconomists drew closer to governments, central banks, and other sources of power, much of the trend in microeconomics went in a different direction. Middle brow theory and topics such as industrial organization or labor economics stayed in touch with those parts of the economy they were meant to study, but the growth of mathematical economics with its high standards of logical consistency was not an unmixed blessing. There is little doubt that the mathematical structure of even a middle sized economic phenomenon can quickly become considerably complex. In order to preserve tractability and to keep the logic clear, economic models in much of mathematical economics tend to be stripped down simplifications

of the world being modeled.

With the advent of the high speed digital computer certain large problems, especially those with a high engineering and operations research content, can be formulated with thousands of variables and computations relevant to a specific problem can be made. But in general, much of mathematical economics has tended towards highly abstract "preinstitutional" structures. Thus the general equilibrium system developed by Arrow and Debreu gave great insights into the meaning of an efficient decentralized price system. But the intellectual results were purchased at a high cost in abstraction and what they had to teach about actual economies was easily subject to many misinterpretations. In particular, the general equilibrium theory developments were nonstrategic, static and noninstitutional. This is not meant as a criticism of the work done. This was the price paid to obtain a tractable abstract model to be used to study the basic features and properties of the price system *in equilibrium*. The abstraction was so good and complete that the problems of price formation, competition and information were completely separated from the study of the existence and meaning of an efficient price system. This separation led to the paradoxical observation that money and financial institutions had no essential role to play in the Arrow Debreu world. This is absolutely true in a static finite period economy where the agents are highly intelligent conscious economic optimizers with a level of trust and ability to foresee the future that is so good that all agents can arrange all trades, payments and credits for all times at the start of trade.

The development of good theory not only calls for Draconian simplifications, but also often makes use of extreme models to serve as benchmarks. The simplifications in the development of general equilibrium are of this variety.

It has been said that one should never blame a religion on its founders. The same holds for a new theory. There is Science and there is the Sociology of Science. New economic theories may serve far more than the providing of insights for a group of professionals. They may also serve as a talisman or an intellectual window dressing to justify a prevailing politico-economic position. Thus, the stripped down institution free, timeless, high level of abstraction of general equilibrium theory, together with its mathematical incomprehensibility to the layman, combined with the austere and almost mystical ideals of

economic man, perfect foresight and perfect competition[2] form a very attractive intellectual package to give intellectual respectability to proponents of the benefits of "economic freedom" and untrammeled competition.

The mere fact that little is known about price adjustment, that in the competitive equilibrium theory little is implied about welfare,[3] that the role of the firm, corporation, managers and stockholders are at best inadequately modeled (except as requirements for the theorems developed) will not bother partisans in search of intellectual justification.

The abstract static, context free approach to microeconomic theory turned out to be highly fruitful in exploring some of the basic static properties of the price system. It helped, among other things, to illustrate that the old Lange (1936), Lerner (1944) debate about the role of a price system in a centralized socialist, as contrasted with a decentralized price forming economy with many competitors, could not be resolved by merely looking at equilibrium. Once the "right" (equilibrating) prices are given, then either the small competitive entrepreneur or the socialist manager, using these prices as a signal on which to condition his behavior, will "do the right thing." However if the central planning agency announces the inappropriate prices there is no guarantee that the socialist system will send out signals which make it easy to correct the prices. Furthermore if the enterprise system starts with prices away from equilibrium, there is little known, in general, as to how the system will adjust.

In spite of the proliferation of mathematical economics in the last fifty years, there has been a growing unease and realization that the development of a science of economics does not lie alone in the development of mathematical or statistical methodology. It requires considerable understanding of both economic behavior and institutions which provide the context for the behavior. An "economics imperialist" might claim that the institutions of society are themselves determined by basic economic principles. But this reductionist view not merely ignores the possibility that human life consists of more than economics, it also fails to appreciate the different time scales on which much behavior is based. The businessman acting

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[2]It seems to bother almost no one that there is a glaring difference between the verbal text in Debreu's (1959) book on the theory of value and the mathematics. The words seem to indicate that competition is being discussed, yet the basic theorem is independent of the number of competitors.

[3]The equilibria may easily be nonunique with completely different final distributions of resources to the individuals.

today may include in his guesswork possible variations in corporate and individual income taxes for the next year or two -- but he accepts the structure of most institutions and laws as given, even though he may know that the opinions of society and the long run influences of politics may modify many of the laws and institutions in a longer run than is usually of concern to him.

If not consciously, then at least subconsciously many businessmen and bureaucrats are well aware that they are at best relatively short term local optimizers in a longer run evolutionary system. However given the context of the system at any point in time, a description based on local optimizing behavior may be of some explanatory value.

Institutions and Behavior: Mathematical, Institutional Economics

In spite of the magisterial works of Marx and Keynes and other grand theorist-publicists, it is a safe bet that a true economic science will never provide predictions for all societies at all times, without much *ad hoc* specification. The application of a viable economic theory has to require a considerable amount of hand-tailoring of the relevant institutional, technological, societal and political details of each society to which it is applied, for the simple reason that as much of economic activity is based on a shorter time horizon than the political, legal and social forces which provide the context for economic behavior. The economy is embedded in its society and polity, it is in essence an open system. Tobin (1982) has remarked that the big macroeconomic models may be regarded as general equilibrium systems. But that only holds true after considerable specification of the exogenous features influencing the model have been specified.

General equilibrium theory, as noted above, taught us many lessons of value, yet threw out the whole monetary and financial structure of the economy and ignored the polity and society in which the economy is embedded. What, then, are the next steps needed to go beyond general equilibrium? It is proposed here that the next steps can be taken, beyond general equilibrium theory, maintaining at least the high standards of rigor and logical consistency and completeness in the modeling of the economy, but progressing towards an economic dynamics. This involves two relatively different, but interrelated tasks. The first calls for the understanding of the role and the necessity of the role of institutions in the economy and the second is the construction of better, more sophisticated models of economic and other individual behavior than is manifested in the simplistic approximation of economic man by the individual rational optimizer. The first

task we are ready to do now, but the second task still involves many unknowns.

The attempt to model the simplest of economic activity as a well defined game that is both playable and susceptible to economic analysis forces on the modeler the need to invent, albeit at an elementary level, virtually every financial instrument and institution known to economic history. The reason is that in order to completely describe a playable game all the rules describing the scope of all moves and information conditions must be given, but these rules of the game, in essence are reflected in actual society by the laws, institutions and instruments governing economic activity. It is important to note that nothing has been said description.

The Methodological Approach Adopted

The approach adopted here owes a considerable intellectual debt to both general equilibrium theory and to game theory.

It is my belief that General Equilibrium theory adopted the appropriate level of rigor, but the modeling was oversimplified in a way that makes compatibility with dynamics extremely hard as it does not present a process analysis. The economy is presented as a tightly coupled system with no need for money or credit and no role for time.

In the development of a satisfactory theory of economic dynamics there is an intermediate stage between statics and dynamics. That stage calls for the construction of fully defined process models which are solved for their equilibrium properties, without considering their disequilibrium behavior.

The class of games called *Strategic Market Games*, discussed below, provides the structure adequate for the construction of process models. Furthermore the idea of a playable game, which is critical to experimental economics, provides an excellent way to test the plausibility of any model constructed.

The basic approach adopted is first to find a simple mechanism (institution or set of laws) which enables us to construct and analyze a playable game, then generalize to broad classes of mechanisms which may also serve to ... (alternative institutions).

I stress the principle of searching for a minimal financial institution as the logically simplest mechanism which provides a recognizable economic function such as price formation or lending or insurance. The approach is to split the problem into many simple separate subproblems.

A basic question which underlies the work is at what level of complication does a new financial phenomenon appear.

The criteria for model building are the logical necessity for completeness and consistency of the model and playability of the game, crude consistency with history and current empirical information, optimality and minimization of exogenous rules.

Institutions and Strategic Market Games

The approach adopted is to employ a class of game theoretic models called *Strategic Market Games* (Shubik, 1973; Shapley and Shubik, 1977; Shapley, 1976; Dubey and Shubik 1978). Technically they are games described in strategic or extensive form which are then solved for their noncooperative equilibria. But without going into the technical detail, it is important to stress the basic idea of a game that is playable as well as one which can serve as an object of mathematical analysis. The economy, for better or for worse, functions with most activities taking place without many of the economic agents requiring a Ph.D. in mathematical economics to buy the groceries, run a store, or even run a bank. Thus the approach is, to some extent, no more sophisticated than the approach used in designing a parlor game such as Monopoly, or a game involving auctioning or bidding or bargaining in a class filled with high school students or undergraduates. Do not worry prematurely about optimality and sophisticated phenomena, ask of the game, is the process well defined and can an individual of average intelligence be taught fairly quickly how to play?

A theory which goes beyond the insights and understanding of the price system provided by general equilibrium theory should at least confirm the previous theory's insights, as well as yield more. Thus even if we construct playable market games of the economy, if we assume that all individuals act in the manner suggested by microeconomic theory and if we are willing to study the system for its equilibrium states, we should be able to obtain the results obtained with the previous theory. This can be done.

The relationship between general equilibrium theory and strategic market games, solved for their noncooperative equilibria, is that under appropriate conditions they both predict the existence of a price system. But whereas the competitive equilibrium theory suppresses the role of information and trust, the role of money and the economic and legal conditions needed to minimize reliance on trust must and can be

made precise in order to well define a playable strategic market game with the appropriate equilibria.

Jevons' observation on exchange among three or more individuals was that in each bilateral trade one individual had to have direct value for the goods offered by the other and vice-versa, if trade were to be motivated without considering retrading. This condition he called the role of the double coincidence of wants in trade. If money (say gold) had this property all would accept it even if they did not immediately intend to exchange it again. The concept of enough money in an economy which uses money is related to a legal or societal acceptance of the double coincidence of wants feature by all for money, and the game theoretic meaning of an economy with enough money is that all trades, being value for value, the equilibrium can be enforced with no need to grant any form of credit or to use futures markets.

Mathematically the meaning of enough money in an economy is that the optimization problem, which involves not merely a budget constraint but a cash flow constraint or a period by period settling of accounts, yields an equilibrium which is not constrained by the need to balance the books each period.

Empirically the existence of a suitable commodity money in sufficient supply is unlikely -- hence the next best is to try to supplement commodity money with paper or credit or to replace it completely. The problem is how to do this minimizing the need for trust or for cumbersome enforcement rules.

Trust, Money and Financial Institutions

If we accept the proposition that the financial system economizes on trust and provides a division of labor for data processing and evaluation, then without being specific about the details and names of various institutions at specific locations and times in history we can provide a broad sketch of the functions to be satisfied and can construct a series of playable games which illustrate the functions. The specifics are given in Shubik (1993).

Bilateral Trade

Bilateral trade which can take place between pairs of individuals in a small society, satisfying the double coincidence of wants, soon becomes costly in time and other resources. As the number of individuals and commodities increases, the number of potential pairwise matchings increases geometrically and the knowledge by each individual of who holds, what, how much and where, decreases quickly.

The Emergence of Markets

The inconveniences of bilateral trade, especially for many individuals, can be overcome by the utilization of markets. In essence, a market is a location or a communication network known to many individuals where all potential participants know that there will be buyers and sellers or exchangers of certain commodities or services. There are many different market structures depending on a host of fine details.

Price Formation and the Market Mechanism

There are many different ways in which price can be formed.[4] The specifics of price formation depend, in general, on institutional and technical details and on the nature of the information structure. In essence the market is a black box which transforms distributions of goods held by many essentially anonymous individuals into other distributions and, in many instances, produces prices.

A way to start to understand the overall structure of markets is first to investigate in detail some simple price formation mechanisms and then generalize to large classes of mechanisms.[5]

Market Structure

A market structure for an economy as a whole may be considered as a collection of markets. At its simplest level of abstraction it can be defined in terms of a graph. Given m commodities, and defining a simple market as a market where good i can be exchanged for good j we can consider a good as a point and a simple market as an arc connecting two points.

Complete Bilateral Trade or Trade in Money

If all pairwise trades are feasible there will be $m(m-1)/2$ markets for trade involving m goods. Even if everyone knows where to go to exchange bananas for oranges, if the economy has even a few thousand goods the number of bilateral markets required soon becomes unwieldy.

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[4]The two major simple models for price formation had their origins in the work of Cournot (1838), Bertrand (1883), and Edgeworth (1925). These mechanisms are reflected in the development of Strategic Market Games (Dubey and Shubik, 1978, 1980; Dubey, 1982; Sahi and Yao, 1989; and Yao, 1987).

[5]This can be done by adopting an axiomatic approach where the essential and desirable properties of markets are axiomatized. See Dubey, MasColell and Shubik (1980); Dubey, Sahi and Shubik (1993); and Dubey and Sahi (1989).

A way to cut down on the number of markets is to select a commodity whose intrinsic properties are such that all desire to possess at least some of it. Trade is then confined to trading all the other commodities in exchange for this commodity. But this cuts down the number of markets needed for efficient trading from m(m-1)/ 2 to m-1 and this represents a considerable saving in the number of markets needed for trade.

Enough Money and Liquidity

For a market structure which uses a commodity money to be able to achieve efficient trade there must be "enough money." The concept of enough money involves both the absolute quantity and its distribution. This can be seen easily, by considering an individual who owns many goods desired by others but has none of the commodity money. If all trade requires "cash on the barrelhead," he is not in a position to buy anything until he has sold something. In essence, although he is rich, he is illiquid. If the economy as a whole is to have enough money, the total amount of all of the commodity money (we will refer to it as "gold" from here on) must have a value equal to all trade.[6]

One of the problems in trying to understand the value of commodity money is that as soon as one contemplates many periods of trade the worth of the gold or bricks or tea or tobacco may no longer depend only on its intrinsic value as a consumer durable or a storable consumable, but on the expected value of its services as a trading device.[7]

Obtaining enough Money and Liquidity

The definition of "enough money" depends on: (1) the transactions technology (including such arrangements as the existence of clearing houses); (2) market structure (including the possibility that part of trade avoids the established markets -- and probably the tax collector as well); (3) quantity, i.e. the actual amount of gold or tobacco available and (4) velocity, i.e. the frequency and speed at which trade takes

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[6]Technically, each individual in the economy faces a convex program, where the condition that all (or some fraction of) trade must be paid for in gold amounts to imposing an extra cash-flow constraint on his optimization. He will have enough money at an equilibrium if this constraint is not binding on his optimization. If it is then gold will have a price above its utilitarian worth and this price will reflect a premium in value consisting of the shadow price of the capacity constraint.

[7]This point requires a somewhat formal development and is given in Dubey, Geanakoplos and Shubik (1992).

place. Each of these factors requires separate consideration.

Fixing velocity, market structure and technology, the conditions for enough money split into three cases. They are:

(1) Enough money well distributed
(2) Enough money not well distributed
(3) Not enough money

Enough money well distributed implies that the trading of no individual is constrained by cash flow considerations.[8]

The Need for Credit and Bankruptcy Rules

If there is enough money, but it is not well distributed, some individuals will need to borrow and others will be in a position to lend. We may introduce a loan market for "gold" against IOU notes. But at this point in trying to be precise and as simple as possible in defining the functioning of a loan market, many special distinctions need to be made concerning the possibility of default, the nature of the loan agreement, and the mechanisms for the clearance of the loan market. The simplest mechanism is a money market where the gold of all of the lenders is pooled and lent to all of the borrowers in proportion to the IOU notes each bids (denominated in gold to be paid at the end of trade). In fact a money market is more complex than this elementary clearing device. It involves brokers and bilateral contracts and the market itself may evolve as an institution with members and rules.

At a different level of complexity in lending an intermediary such as a bank or other financial institution may step in and act as an agent or principal who pools the funds for lending and performs the information gathering, evaluation and administration involved in borrowing.

Regardless of the mechanism, one clear new feature emerges when trade is paid for in money and efficient trading calls for some traders to need to borrow. If the system can achieve a state at which some borrower is unable to pay his debts, then there must be rules, laws or customs that specify how this failure is to be resolved. If we attempt to build a playable game of an exchange economy using gold as a means of payment and the economy has a money market, then rules must be given to cover bankruptcy and default.

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[8]If there is enough money, well distributed, the competitive equilibria (CEs) of the exchange economy and the noncooperative equilibria (NEs) of the strategic market game (SMG) will coincide. Without the need for the granting of credit or the requirement of any enforcement laws all NEs will be fully supported by the double coincidence of wants.

If (contrary to experience) we could imagine a world without uncertainty or incompetence, then as everyone would plan with great foresight, the only source of default would be strategic bankruptcy, i.e. individuals defaulting deliberately because it pays them to do so. This indicates that in such an economy the optimal bankruptcy laws need to be such that for all borrowers, honoring their debts is preferred to suffering the consequences of bankruptcy.[9]

When exogenous uncertainty is present in the economy, the design of optimal bankruptcy laws becomes problematical. Different treatments may be desirable for bankruptcies caused by strategic intent, incompetence or ill fortune, but it is difficult to sort out the causes.

The Production of Money

If there is not enough gold[10] in the economy to permit trustless trade, historically societies have provided several direct solutions. More gold has been mined or imported, or otherwise fiat, or "outside" money, an imaginary commodity money, has been invented.[11]

In actuality gold mining is expensive and it is empirically hard to find an economically suitable commodity money. Thus the trend since 1700 A.D. has been towards paper, and with paper the whole apparatus of law, commercial and central banking has grown in order to control and vary the supply of an imaginary commodity whose physical manifestation has been replaced by an abstraction utilized as a substitute for trust.

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[9]It can be shown that in a one period exchange economy with enough money, badly distributed, and an optimal bankruptcy law efficient trade can be achieved utilizing a loan market in which the rate of interest is zero (Shubik, 1990).

[10]The precise mathematical meaning of enough money requires some precision (see Dubey and Shapley, 1977, 1993). Intuitively, we can consider a class of economies where more "gold" is given to everyone -- as the amount of money is increased there will be enough money if after some point the system will finally have interior NEs. For this to happen conditions are required on the utility functions. In particular the money must always maintain a finite rate of exchange between it and every other commodity.

[11]The nonmonetary worth alone of a commodity money may enable it to serve as a substitute for trust in exchange, but in an ongoing economy (as can be seen from a dynamic programming analysis) it also assumes value as a money. A fiat money does not have nonmonetary worth (except as a collector's item) its value is supported by its worth as a means of payment and this in turn is brought about by a mix of the rules of the game and the solution.

The Velocity Fix

Rather than produce more money or switch to paper, if there is not enough money we could try to increase the speed of payments.[12] Formally this can be done, thereby reducing the float or need for bridging finance to zero (see Dubey, Sahi and Shubik, 1993), but practically trading takes some time and it is communication many changes are being made in the methods of payment and these have considerably reduced the float.

When times are prosperous, individual sloth and corporate organizational slack may slow payments and when times are lean, more attention is paid to the timing of payments. However, for fairly obvious physical reasons there is a finite lower and upper bound on velocity, and variation in the velocity of money makes it more difficult for the economy as a whole to achieve the appropriate adjustment of the money supply.

The Market Structure Fix

When there is not enough money in an economy, the introduction of new nonmonetary markets can help to alleviate the shortage. Individuals could (and do) exchange goods and services directly.[13] New nonmonetary exchange and credit arrangements among individuals well known to each other may not be overly expensive (hence credit deals between firms and their regular suppliers), but otherwise new relatively anonymous markets add search, policing, data processing and other costs and will only come into being when the lack of a trustworthy formal money in sufficient supply makes them an economically viable alternative.

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[12]For some formal models see Shubik (1993, Chapter 15).

[13]For m goods, instead of staying with a single money and $m-1$ markets we could introduce up to $m(m-1)/2$ markets, but it can be shown (Amir, Sahi, Shubik and Yao, 1990; Sahi and Yao 1989) that although with all binary markets every good is a money there are still problems with its distribution. There are two strategic market game models with all binary markets which differ in the presence or absence of a clearing house. The Shapley "windows" model has a clearing house and the Shubik "trading post" model has no clearing house. In the former the presence of the clearing house provides short term trust and there will always be enough money, well distributed. In the latter the no arbitrage law of pricing may fail (see Amir, Sahi, Shubik and Yao, 1990).

The Credit Instrument and the Commercial Banking Fix

Most modern societies opt for the credit instrument fix in order to adjust the money supply. Thus checks of commercial banks written on their deposit accounts as well as several other forms of paper and plastic, for many transactions are "as good as money." The acceptance of a check implies that the public believes that the private bank has done its homework and will be in a position to honor its debt.

A central bank with many branches, each estimating the monetary needs of its local population could serve as the mechanism for providing enough money. Historically, however, the technology of trust and its administration developed via commercial banks, whose existence in one form or another can be traced back at least as far as the Babylonian empire.

As long as there was a commodity money as the ultimate surrogate for trust, there was no need for a central bank and appropriate laws to supply the constraint on the "extra degree of freedom" in the system caused by the physical disappearance of the commodity money. The disappearance of commodity money has been accompanied with the appearance of the central bank starting essentially in 1694 with the charter founding the Bank of England (see Clapham, 1958 or Andreades, 1966).[14] The institutional details of the various hybrid systems of central and commercial banking are of interest in illustrating the local differences in the nature of the many functions performed by the central banks[15] (such as being the government bank and attempting to influence exchange rates). But the key function is control of the money supply.[16]

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[14]The Swedish national bank is sometimes referred to as the earliest central bank. The Rikets Standers Bank of Sweden was founded in 1668 however it was not called the Riksbank (national bank) until 1867 and Goodhart (1988, pp. 122, 123) suggests that it did not really function as a central bank until 1897.

[15]Many of them depending upon information conditions, evaluation and quality control of credit granting.

[16]When fiat replaces a commodity money, any attempt to model the economic system must deal with the problem that a system where the money supply was well defined by a physical process such as gold mining is replaced by a system which must specify what is meant by the quantity of fiat, must show how it is produced or destroyed and must indicate how it has utilitarian worth.

Long and Short Term Credit

The only use for money in a one period model of an economy is bridging or float financing.[17] In one period there is no distinction made among services, durables or consumables in their evaluation. It is difficult to distinguish a stock from a flow. This changes radically as soon as two or more periods are considered. In an economy with more than one period even without exogenous uncertainty money plays three major roles:

(1) It covers the float and provides bridging finance;
(2) It takes care of the financing of intertemporal trade;
(3) It provides for the financing of capital stock.

Finance involving the long term brings with it the need for borrowing to cover desirable intertemporal trade, but along with the need for long term debt comes the supply of long term assets which can serve as hostages or security against debt (Shubik, 1993, Chapters 17 and 20). Durable capital goods whose value is expected to be sufficiently high provide a basis for borrowing with secured loans and hence with less trust than otherwise (except in judgements about expectations of future value of capital stock).

Unfortunately assets with long lives bring in new difficulties as well as new opportunities. As long lived assets they may be of considerable value and hence be important hostages. But in spite of our knowledge of how to sum discounted expected income series, when one is evaluating the worth of an asset more than five years out the number of imponderables in making the predictions of expected value increase. In practice many lenders give the asset a "haircut" in its evaluation. This acknowledges their inability to make close evaluations and offers the protection of conservatism in lending.

[17]Even with only one period, in an economy with a price formation mechanism one has to create some form of float, if only for a brief time in the process of price formation. The actions of the individuals form the price, hence price (as contrasted with expected price) cannot be given in advance. A clearing house implicitly grants a short term credit for the time it takes to match all claims.

Corporations and Common Stock

Although the fundamental distinction between debt and equity is based on the presence of some form of uncertainty,[18] the size of many modern manufacturing processes and the capital requirements needed to finance them called for the modification of the corporate form to be used by commercial enterprises and the invention of the share or common stock. The share represents the part ownership of an indivisible whole. The owner cannot claim a fraction of the physical assets involved, but he can trade to a third party the shares which are a symbol of ownership. But the growth of enterprise size meant that administratively it became impractical for many hundreds or thousands of joint owners to participate in management. This in turn brought forth, primarily in the latter part of the 19th century, the limited liability laws. Even at this time, the efficiency and equity aspects of the managerially run corporation and the design of the relationship between its managers, stockholders and others is not fully understood.

Exogenous Uncertainty and Incomplete Markets

Even without outside uncertainty in the economy, a society without perfect trust will require financial institutions. But it is a fact of life that outside uncertainty abounds in everyday life. As Arrow (1964) noted, a sufficiency of the right type of financial instruments could rid a society of all risk. But this interesting, basic result depends on the knowledge of all probabilities and the irrelevance of costs in producing and trading the instruments.

An underlying major feature of the general equilibrium system is that the equilibrium prices are efficient, in the sense of Pareto optimality, which means that the welfare of no individual can be improved without diminishing the welfare of another. But this efficiency cannot be so easily defined when there are missing markets or when there are transactions costs present. At best, one can resort to a comparative analysis of institutions in a range of operations. Depending on the range their relative efficiency may change.

In the writings on macroeconomics little time is spent on discussing the efficiency of the price system. An open question, of some difficulty to formulate precisely and to answer is how important is the potential

[18]It is of interest to note that Modigliani and Miller (1958) in their argument to demonstrate the irrelevance of corporate financial structure essentially ignore incomplete markets and leave out bankruptcy which is a logical necessity if the system can ever attain a state where debts cannot be honored. Their result in general, is not true when these extra features are considered.

for gain in adding markets to our existing economies.

The economic facts of the existence of economies with incomplete markets, processes which take time and require borrowing for more than one period complicate many of the aspects of the credit markets and call for the development of financial institutions which are able to lend both for the short and the long term. As soon as random events can intervene from period to period the relationship between the short and long term rates of interest becomes complex. Without uncertainty, in equilibrium, a two period rate of interest is simply the product of the two one period rates. But with uncertainty a complex term structure emerges where considerations of liquidity and risk aversion must be taken into account.[19]

As the length of time increases, does uncertainty increase or decrease? Depending on the process and the measure, it can go either way. But a characterization of the distinctions made among different financial institutions such as commercial banks and investment banks is often based on length of loan and riskiness.

The presence of outside uncertainty highlights the importance of expertise and nonsymmetric information conditions in finance and investment. If an individual, through superior information and interpretation of the information knows several months ahead of all others that an event will take place, his expertise and superior information may reward him, time and time again, even though the markets reveal *after the facts* what he has done (see, Dubey, Geanakoplos and Shubik 1988).

Bankruptcy, Uncertainty and Reorganization

In an ongoing economy with both strategic uncertainty from the actions of economic agents and outside uncertainty from the actions of the polity, society and Nature in general the possibility of failure due to bad luck, incompetence or dishonesty abounds. The bankruptcy laws must cope with all of these possibilities. Furthermore in a dynamic society, as there may be a tomorrow for all parties the laws must cover creditors, debtors and influenced bystanders. The physics and economics of the utilization and disposal of resources must be spelled out. They do not disappear, they are misallocated and the results of the failed birth of a new industry or botched growth of an old firm must be reabsorbed by the ongoing process. Thus it must be stressed that bankruptcy rules, even though they may contain some deterrence

[19]In particular, aspects of a serial law of large numbers are present, the longer an individual borrows. In a highly variable process with many negative elements, if he has to pay back his loans each period he has a far higher chance of bankruptcy than if he has to pay back once in twenty periods.

factors against criminal behavior; must be concerned, far more generally, with the setting of the sanctioned risk profile of society as a whole.

The forces of evolution depend centrally on birth and death processes and the bankruptcy and reorganization laws and customs reflect the socio-politico-economic forces influencing the birth and death of firms.

A paradoxical result may be obtained if we attempt to answer the question "Can one design an optimal bankruptcy law in an economy with exogenous uncertainty present?" The answer is yes (Shubik, 1993, Chapter 23), it is possible, using an outside or central bank as the only source of credit to have a combination of limited lending, high interest rate and liberal default rules which enable the central bank to act as a perfect insurer. The problem with the model is that it requires three counterfactual assumptions, all of which depend on information processes. They are that: (1) the bank has an accurate estimate of the expected income of all; (2) It knows exactly what random event has occurred for each agent; and (3) its investigation cost and collection costs from each agent are zero.

In summary, bankruptcy is public good which must cover the interests of all parties in its resolution. Furthermore it is closely related to the processes of innovation in a society. It helps to control the trade off between the costs of failure and the values of successful change.

Insurance and the Quality of Risk

The central development of the microeconomic decision theory under uncertainty makes it appear as though all problems involving risk can be equated with situations with the choice of selecting among a set of lottery tickets. But although the emphasis in economic theory[20] has been on this type of formalization of risk, a central feature of a financial system is the concentration of financial expertise; furthermore much of the expertise is directed towards the evaluation of risk and the risk profiles of the individuals dealing with risk. The growth of modern financial institutions has been marked with the proliferation of specialization. Insurance is not merely insurance, it is casualty, life, fire, marine, bail bonds and so forth. Even if a single "supermarket" holding company supplies all types of insurance, it will do so through subsidiaries or special departments. At the highest level of abstraction eventually these items may be

[20]Possibly this stress has been present since the von Neumann-Morgenstern analysis of preferences and utility under uncertainty which concentrated on preferences among lottery tickets.

described as lottery tickets, but the more important contributions of the financial system are not the deductive manipulation of betting odds, but the inductive aspects of gaining insights and obtaining better estimations of what the odds happen to be.

In the past few years, basically because of the expansion in computational abilities and the growth of "financial engineering" there has been a proliferation of new markets and instruments as the various aspects of risk are broken into more and more dimensions. Thus what once was a collection of mortgages or a foreign bond is now carved up in a financial specialist's meat market into many new pieces of paper, some bearing interest risk, others the default risk, others foreign exchange risk and so forth. The replacing of a few dimensions of risk perception by many and the specializing of instruments to cover different aspects of these risks is probably (all other things being held constant) risk reducing to the system as a whole. But there are many other considerations. In particular computations based on poor concepts, wrong perceptions or irrelevant data may give the semblance of high science and engineering, but could, in fact, increase the instability of the system as a whole.

The importance of accounting conventions and taxes in economic activity cannot be overestimated. The introduction of new instruments under the guise of ameliorating risk creates a class of hybrids which may be instruments which are not direct debts, or assets but have those properties under certain circumstances. This means that there are new opportunities for strategic distortions of corporate balance sheets. In a system where accurate evaluation depends considerably on the availability of clearly understood data these new possibilities are accompanied with new dangers.

The Infinite Horizon

The original work on general equilibrium postulated a finite horizon. Economic agents sprang full blown from Zeus' ear, traded and produced for some given T time periods, maximized their utility and vanished at the end of time.[21] A better picture of the world we live in has time on a continuum with no clear start and no clear end. Thus in the development of mathematical economics after time going from 0 to T, models were developed with time going from 0 to infinity and then from minus infinity to plus infinity. Then after that, in recognition of the finite expectation of the lives of individual rather than

[21]Existing mathematical technique is frequently the mother of modeling. By keeping the time horizon finite it is easier to guarantee that certain sets one wishes to be compact are compact.

postulate mystical dynasties which live for ever, the overlapping generations models (OLG) were developed.

In terms of the understanding of assets and money the difference between the finite horizon and infinite horizon models is of some importance. In designing a playable game which ends at time T the game designer has to specify how the money and the physical assets come into the economy, but he is also required to specify what happens to left over physical assets and money and remaining debt at the end of the game. A trick (borrowed from dynamic programming)[22] is to have the referee or game controller post a set of prices at which he will buy back left over assets, or credit the game players at the end of the game. When the game has no ending date then there is no final settlement date which must account for the disposition of all working capital and fiat money. But it is precisely these, possibly arcane, mathematical conditions which open up the possibility for financial instruments such as the British consol bonds with no redemption date and allow for the possibility of the continuous roll over of debt and shady financial practices such as the Ponzi game which amounts to a sequence of new borrowings, each used to pay off the previous borrowing.

It is possible to construct models of the economy with an infinite horizon where the economy uses fiat money, utilizing the methods of dynamic programming (see Bewely, 1986; Karatzas, Shubik and Sudderth, 1993; Shubik and Whitt, 1973; Stokey and Lucas, 1989). These models, along with those of Grandmont (1983) and others demonstrate that the appropriate *expectations* that paper money will maintain its value may be sufficient to have it maintain its value. However they give no insights into the inductive process whereby the agents form the appropriate expectations beyond invoking the self-fulfilling properties of noncooperative equilibria.

When an infinite horizon economy utilizes fiat money for trade and is subject to exogenous uncertainty, the maintaining of balances of fiat as precautionary reserves, as suggested by Keynes emerges as part of the solution (See Karatzas, Shubik and Sudderth, 1993).

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[22]This is the salvage value structure which enables one to study the relationship between a finite and an infinite horizon dynamic program.

Overlapping Generations

The infinite horizon models complete with infinitely lived human agents conflict with our views of human reality and leave out the major mechanisms for mutation and other forms of change. The key links with biology of birth and death are missing. The work of Allais (1947) and Samuelson (1958) provided models which took into account the finiteness of the human life span. But although the need for money and most financial institutions is logically independent of the finiteness of human life and the nature of overlapping generations, empirically the OLG models are far closer to reality. But the introduction of the overlapping generations formulation of the economy introduces the need for a host of new considerations which show the essential openness of the economy to biological considerations and the society and the polity. In particular in order to well define the models to be analyzed, the conditions on birth and death must be specified. Most OLG economic models take these as given, but especially when we contemplate developing economies there may well be important feedback between the birth rates and the economy.

As some assets may last longer then their owners[23] it is necessary to specify the inheritance laws of the society. Furthermore, as at least, in the current laws corporations are legal persons with potentially infinite lives, a consideration of the logical structure of economic decisionmaking requires a more careful specification than the Panglossian finesse, employed in many writings in financial economics, of the existence of selfless managements devoted to maximizing the welfare of the stockholders.

The Games Within the Game

A way of viewing an economy with overlapping generations of humans with a finite life expectation, controlling assets and institutions whose expected lives are longer than their owners, is as a game within a game.

The institutions are not live strategic agents, but at many points in time are not only controlled by the humans but control the humans, at least by imposing considerable constraints on their strategic choice (see Shubik, 1993, Chapter 24). Although the for-profit, and the not-for-profit corporations and government are not live players, they nevertheless are strategic agents. A model which reflects this has the humans, each with several strategic roles in different, but interlinked games, each involving various agents at different

[23] An attractive science fiction scenario would be to have a group of houses in a neighborhood reminisce with each other about the sequence of people they have possessed.

levels of intensity. Thus for example we may consider each individual as having inputs into essentially four interacting games, (1) the economy, from the viewpoint of individual consumption and employment or production; (2) the economy from the viewpoint of corporate ownership and control; (3) the polity from the viewpoint of the voter or active politician or bureaucrat (see, for example Dahl's, 1961, perceptive study on the intensity of political participation); and (4) the society from the viewpoint of individual interactions with, and control of, the not-for-profit institutions.[24]

The individual agent has moves in as many as four arenas. They tend to be with different intensities and on different time spans. They fit more comfortably into a behavioral or limited or constrained rationality point of view than the resolutely rationalistic maximization of *homo oeconomicus*.

The moves in each of the arenas of corporate or governmental control result in these synthetic persona making a move which for the most part may consist of setting parameters or other aspects of the environment in which the individual's short term activity takes place. Thus as was partially noted, at the start of this article, the overall interaction can be viewed as the short term myopic decisionmaking of the individual agents not merely yielding immediate payoffs, but modifying the environment in which the next game is to be played. Rather than a closed economy with super rationalistic agents optimizing we have an economy embedded in a polity and a society where many of the actions of the agents feed back on them or their progeny via the artificial players producing an evolving system driven by local optimization.

International Finance

The structure of modern international financial institutions is possibly in the highest state of flux of all economic institutions. The pressures of growth of population and changes in computer and communications technology are compounded by the politico-economic and legal problems concerning the roles of competing nation states. This is an area of political-economy where socio-political context is critical.

In the next half century the odds favor the evolution of a world central bank and steps towards more and more unified bankruptcy laws and commercial codes.

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[24]One also, at least, wishes to attempt to account for the broader context of the influence of the broad cultural environment on the individual and vice versa. This is both extremely difficult and of dubious worth to model mathematically in a satisfactory manner.

Much of the debate will have the window dressing of economics and finance, but the political realities will involve the gradual recognition of the giving up of certain aspects of national sovereignty in return for steps towards global economic coordination, if not unification.

Conclusions and Prolegomena

There is an old New York story about sardines:

> An importer sells cans of sardines to a distributor who sells them to a retailer who sells them to his customers who eat them and almost die of food poisoning. The following conversation then takes place.
>
> > Importer to distributor: "I do not understand why you are complaining to me; both you and the retailer made your usual markups."
> >
> > Distributor to Importer: "But you do not seem to understand the sardines were sold to consumers who ate them and almost died of poisoning. They are going to sue us all."
> >
> > Importer to distributor: "You fool, those were trading sardines not eating sardines.!!"

There is also the New England saying:

> "In God we trust, all others pay cash."

A basic test in the construction of an adequate theory of money and financial institutions is to be able to examine, evaluate and formalize the business and folk wisdom and to be able to mathematize and analyze those features which are of intuitive worth. These two sayings tell us that money is a surrogate for trust and that fiat money behaves like trading sardines, its worth is in its role as a trusted means of exchange.

A combination of the growth of a large educated and highly anonymous population, together with enormous changes in the size and scope of manufacturing, communications and computation technology operating in the context of the nation state with its many institutions providing highly differentiated functions, has created the need for a highly sophisticated financial control system, if a high level of individual choice is to be part of the overall socio-politico-economic system. The choreography required for a complex mass economy with high levels of individual choice is immense. The evolution of the modern financial infrastructure is central to the design of the control system.

The minimization of the need for trust in the economic system is not a symbol of a new soulless society. It is the reverse. Trust is a rare flower and is based on many features which cannot be easily mass produced. Fortunately instead of having to waste trust on strangers wanting to buy a hamburger, or even on a speculator wishing to short the Yen, a financial system complete with communications and

computational devices together with individuals specializing in credit evaluation can regularize, standardize and evaluate broad classes of transactions so that trust is not needed.

This section has been called "Conclusions and Prolegomena" for a specific reason. A sketch has been presented here of the evolution of money and financial institutions. In the work, of which this is a summary sketch, the modeling and mathematical development of the theory of money and financial institutions is presented. The conclusions are that we have the tools and the ability to develop such a theory now.

The word Prolegomena is in the title of this section to remind us that the development of a theory of money and financial institutions is only the first step towards understanding socio-politico-economic behavior. It provides an understanding of the carriers of process, but not a description of the actual processes which are determined by behavior. In order to develop a satisfactory dynamics, a better understanding of behavior is required. The model of *homo oeconomicus* must be replaced by a more sophisticated construct. We return to this point below.

In the development of a theory of money and financial institutions it is shown that by attributing some form of optimizing behavior to economic agents, a combination of that behavior with a host of physical facts,[25] when one attempts to construct a formal model as a playable game, the specification of a complete and consistent set of rules contains within it the financial institutions, instruments and economic laws of the economy as part of the specification of the rules. They emerge as part of the apparatus required to carry process. In many instances the rules are not unique. Chance events and specific cultural or political detail might influence the selection of a viable institutional form and economic pressure may wipe out poor selections. Nevertheless underlying the rich institutional variations there is only a handful of basic economic-financial functions, and if one adds the condition of simplicity[26] of rules and structure, there are only a few basic mechanisms which can be designed to form these structures in their simplest versions. These mechanisms proliferate as soon as the information conditions of the actual world are considered.

A theory which offers an explanation of why some members of a set of financial institutions and instruments will exist is not capable of predicting a specific institutional form. Even with considerable

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[25]Such as the durability of gold, the nontransportability of land, the finiteness of the expected life of the individual, the time structure of assets and the many aspects of uncertainty.

[26]This is more easily said than done. In essence the simplest class of games have single simultaneous moves, i.e. strategies and moves coincide and all agents have only one information set each.

extra contextual detail supplied it is not apparent that the same circumstances will give rise to identical institutions. Yet a theory of money and financial institutions can help to isolate and clarify the basic functions of the system, which are few and immutable and central to which is the efficient minimization of the need for trust in trade.

The explosion of economic theory and the applications of economic thought to the running of the nation state and corporations in the twentieth century has been large and marked by the great growth of macroeconomics in the domain of application, and in microeconomics among the items of note has been the development of general equilibrium theory and the understanding of the price system.[27]

There have been many calls for the reconciliation of the messy, highly institutional and behaviorally *ad hoc* applications-oriented macroeconomics with the intellectually chaste, institution free and highly rationalistic general equilibrium theory. But this reconciliation requires both a better understanding of structure and behavior. Here the outline has been given for the first step, which is the understanding of structure. The insistence on process descriptions of the economy by means of the utilization of strategic market games yields the tools to study the anatomy of financial institutions. But the behavioral underpinnings are still inadequate.

With forethought the approach adopted was both to use the structure of strategic market games to remodel the general equilibrium structure and to use the behavioral assumptions underlying much of microeconomics. These assumptions involve the acceptance of an extremely elementary characterization of the economic agent as a context insensitive, non socialized[28] (in general, ahistorical) intelligent, well informed, optimizing agent with implicitly unlimited abilities to compute and plan. This model of the human is a gross simplification of the actual animal working with incomplete knowledge of the environment, considerable constraints on perception, very limited and time available for computation, who constantly aggregates and disaggregates masses of information and makes use of mass formal and informal communications networks such as friends, relatives, colleagues, consultants and financial and other institutions.

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[27]This does not include the great development in methodology including econometrics, game theory, linear, convex and integer programming, dynamic programming and computational methods.

[28]Or implicitly socialized as an ideal 19th century Western European or American rational utilitarian economic agent.

The reasons for first using the unsatisfactory behavioral assumptions of microeconomic theory are two fold. The first, as already noted, is to see if the new models, under the appropriate circumstances, yield the same results as previous theory. The second is that it provides a way to check and "debug" dynamic models and yields some analyzable examples for problems which, in general, are too difficult to analyze with current methods.

The next steps to be taken are clear, but difficult. The attack must be on models of intent and behavior based on limited rationality. The emphasis must and will switch to the study of inference and expectations and the techniques of simulation, experimental gaming and large scale computation will play more central roles. At best an overall statistical mechanics of socio-economic behavior may emerge where the financial structure of the society serves as a central part of the communication and evaluation system linking the economy with the polity and, in particular, with government.

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