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THE THEORY OF MONEY

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Abstract

Fiat money[2] is a creation of both the state and society. Its value is supported by expectations which are conditioned by the dynamics of trust in government, the socio-economic structure and by outside events such as wars, plagues or political unrest.

The micro-management of a dynamic economy is not far removed in difficulty from the micro-management of the weather. However, money and the financial institutions and instruments of a modern economy provide the means to influence expectations and bound behavior.[3]

Paper money emerges as a virtual commodity. The dynamics of the economy permits it to serve as an imaginary gold. Although it is an abstraction, it is meaningful to talk about its quantity. Closely related to but basically different from fiat money is credit.[4] Credit, unlike fiat money is not a virtual commodity but a two party contract. The fact that it is a two party contract set in a dynamic context implies that there are chances that the economy may reach a state where a debtor is unable to meet his or her obligations. When this happens the laws and customs of the society must provide default, bankruptcy and reorganization rules. These rules are usually denominated in terms of fiat and socio-economic penalties such as the confiscation of assets, garnishing of salary or time in debtors' prison. Thus the value of paper gold is determined in two ways by the dynamics of the system. First by acceptance in trade, based on the expectation that it will remain valuable and second by its role in the discharge of debts where failure to repay has unpleasant consequences. When taxes are present a third valuation appears in the penalties for failure to pay taxes.

The control of the fiat money supply together with rules on the granting of credit and the bankruptcy, default and reorganization rules, in essence, provide lower and upper bounds for the price level in the economy. They also determine the innovation rate of the economy. An innovation may be regarded as an economic mutation; the less costly failure is, the more likely an innovation will be risked.

The rates of interest for loans combined with the harshness of the bankruptcy and reorganization laws help to determine the rate of innovation in a society. Government controls only one among many interest rates. A host of institutional details involving risk and transactions cost determine the others.

The velocity of both money and credit may vary. Even though velocity may vary, human

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[1]My two volumes on the *Theory of Money and Financial Institutions* (1999, MIT Press) provide the acknowledgments and references which are made to the many individuals who have influenced me and to the sources of the many facts mentioned. Furthermore the mathematical development of many of the points noted here is given there.

[2]I use the term fiat or abstract paper money interchangeably to stand for a government supplied means of payment of no intrinsic worth.

[3]Phrasing this somewhat more technically they provide the bounds on the state space. A state space is the set of all feasible states which can be achieved by the system.

[4]Credit such as bank credit from a well known bank may be referred to as "inside money" in the sense that it is a contract between two legal persons in the economy other than the government. Yet the bank credit, because of the visibility and reputation of the bank, may serve as a substitute in transactions for fiat money.

decision-making takes a finite amount of time. This implies that velocity will remain bounded. Beyond some speed of circulation expectations will degenerate and the economy will break down.

In order to appreciate the intrinsic dynamics of a high information and communication mass economy at least three agents must be distinguished. They are the highly visible government; other largely visible legal persons, such as banks and corporations and real persons. Their differences are characterized by their relative power and the size of their communication networks.

The contrast between a market economy and a state economy is not a clean contrast. The distinctions are on a continuum. Among modern democratic market economies the size of the government sector is roughly anywhere from 15% to 50% of the economy. Thus the control description of virtually any modern economy is of one extremely large and visible player; at most a few hundred large corporate entities of reasonably high visibility and a mass of small agents known by and in direct communication with only a few others.

The reconciliation of a dynamics oriented macro-economics with an equilibrium oriented micro-economics lies in the understanding that the economy is embedded in the polity and society. The institutions, customs and laws are the carriers of process and provide bounds to process. They limit the dynamics. The role of macroeconomic policy is to bound the dynamics of an evolving society. Individual behavior is local and necessarily myopic. Myopic local optimization is consistent with global evolution.

An elementary understanding of history and the decision and game theory proliferation of strategies is enough to indicate that the search for a unique or even stationary economic dynamics is an essay in futility. In contrast the search for the correct carriers and bounds on process is feasible. The monetary structure provides the sufficient loose coupling to permit mass independent behavior to take place even somewhat chaotically within institutional bounds.[5]

THE CENTRAL ASPECTS OF MONETARY DYNAMICS

Some years ago, in first contemplating economic dynamics I suggested the term "mathematical institutional economics" in order to call attention to the need to understand institutions as the carriers of process. The mathematics and logic are needed in our search for abstraction and general principles. In the detailed study of process institutional detail cannot be avoided; but by considering the possibility that the monetary and financial system is only of operational interest in a dynamic context the basic properties of money may be examined.

The search for an explicit economic dynamics is a search for the Philosopher's stone. The basic monetary role of the macro-economist and the government in any attempted control of the financial system is to prevent disaster and when feasible influence direction. It is not to predict or micromanage the movement of the economy. The explicit prediction or control of economic process is more difficult than the control of the weather. However our ability to bound the dynamics of economic behavior by the design of the appropriate institutions and laws and the utilization of policy instruments is considerable. The fiscal and redistributive abilities of the government reinforce this control.

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[5]Technically the institutions and the monetary and financial structure fully define the state space, but do not describe the dynamics. There is a robust collection of local individual rules of behavior which are all sufficient to provide the dynamic support of expectations that money will be accepted as having value. The control system may be sufficient to guide or at least limit the overall macroeconomic behavior without necessarily providing for a precise or unique dynamics. Money is the only financial instrument without an offsetting instrument. This nonsymmetry appears to be critical in the introduction of time into the model of the economy.

This essay is devoted to the explaining how the introduction of fiat money and other aspects of the financial system has provided society with the crude but necessary control structure to influence a loosely coupled dynamic economy.

There are three basic aspects to the understanding of the central role of fiat money in a modern economy. They are: (1) fiat money is an idealized virtual commodity; an imaginary gold, (2) the control of its supply is a basic task of the state, and (3) the broad dynamics of the mix of trust, custom, law, communication and information provides the ingredients in maintaining the worth of "worthless" paper or a mere abstraction of value in a dynamic economy.[6]

Abstract money is a substitute for trust in trade. The rules of the economy provided by the laws and customs of the society using a symbolic fiat money can, under the appropriate circumstances support a system dynamics where individual expectations that other individuals will accept this intrinsically worthless paper or cipher will be self-fulfilling. The dynamics may provide for the reinforcement of these beliefs which will provide for monetary stability.

The beliefs have two components and work on two sources of information. They are the beliefs of the individual agent in the acceptability of the money to other agents and the beliefs of the individual agents about the trustworthiness of the "referee" or the central bank or other agent for the government which controls the money supply.

The central government is the most powerful and special agent in the running of a modern economy. It would be so even if its only role were to guarantee the soundness of the currency and maintain the rules of the game (such as the commercial code) required to facilitate individual trade. An important feature of the central government is that it is implicitly or explicitly in direct communication with every economic agent in the economy. In contrast, in the generation of private credit between two individual agents much special information must be generated. "Due diligence" is performed to determine credit worthiness. Reputation helps to decide on prime names and lesser names.

Bank money is a form of credit where the information and communication between the bank and an individual are more routinized than in the arranging of credit between two private individuals. Banks differ from both individuals and the government. The banks and other financial institutions are larger than mere individuals and smaller than the central government. They are far more visible in an information and communication network than are individuals, but they are less visible than government. Bank credit is loosely controlled by government.

The acceptance of government money depends on the beliefs of a predominant part of the society that the government is not going to run the printing presses. In a stable and reasonably honest society it is cheaper and easier to trust the government that random strangers. In return for this trust the government is able to provide a symbolic commodity which is accepted as a means of exchange with the system dynamics converting it into a store of value. It becomes an ideal transferrable paper gold or a substitute for the need for individual trust. If the central government does not "cheat" this (possibly invisible) money behaves approximately as though it were an ideal gold.[7]

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[6]In terms of physical analogy (1) there is a violation of symmetry in the initial injection of outside or government money into the economy; i.e., a financial instrument is created with no offset, it is a virtual commodity; (2) the state controls of the laws of conservation of money and decides how and when they may be violated, and (3) the value of money is primarily a system dynamics property.

[7]Technically it is as though there were a linear separable term in the utility function representation of individual preferences. In essence, in a large enough economy with a price system even though fiat money may be a fiction created by the society and no linear separable term in the utility function exists; to each individual

THREE TYPES OF MONEY AND CREDIT

This section discusses the basic properties of a money and gives a historical sketch of the development of the uses of money in various economies. It stresses the distinction between government money and all other financial instruments, including bank debt which is a common close substitute for government money.

All financial instruments, except for one, are necessarily created with an off-setting instrument which may be another financial instrument or a real asset. The IOU note of the bank is balanced against the IOU note of the individual in a bank loan; the assets of the firm are balanced against the stock of the firm. The sole exception is government or outside money. Operationally a dollar turned into the government yields only another dollar.

Historically, weights of some commodity preceded coinage and were used for exchange around five thousand years ago in Babylon and Egypt. Coinage in precious metals entered trade around 630 BC and within a few years of its introduction in Asia Minor spread over the civilized world. Paper money became a serious economic force around the end of the seventeenth century with the founding of the Bank of England and the late twentieth century brought with it money as a pure abstraction. Credit has existed at least five thousand years as is evinced by the records of debt instruments in Sumer and the other ancient kingdoms in the fertile crescent. The granting of credit predated the invention of coinage by at least two thousand years.[8]

The instruments which are sufficient for our understanding of the nature of money, its functions, creation and destruction are: (1) A consumer durable money such as gold; (2) A storable consumable such as bars of salt, measures of grain or bricks of tea; and (3) Fiat, government or outside money. These all must be considered in terms of the properties assigned to a money.

Before the individual instruments are discussed the basic properties of a money are considered.

The properties of a money

Any standard text will specify the three major conventional uses of money. They are:
- The numeraire;
- The means of payment and
- A store of value.

However when the dynamics of the financial system as a whole is considered, at least two further properties of a money are important.
- It serves as a "strategic decoupling" device in decision making.

This means that unlike in barter, transactions do not match in goods for goods but any difference in value is made up with the special good, money. Thus the system runs easily in disequilibrium.
- The rules of the game concerning the actions of agents utilizing money, differentiates among the agents. The strategy sets of individuals, financial institutions and the government are all differentiated.

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in the neighborhood covered by his or her purchasing power money acts as it were such a commodity with its marginal value given by a Lagrangian multiplier. The value of the Lagrangian can be viewed as resulting from the self-fulfilling expectation by all that others will accept the money.

[8]Credit may be regarded as "inside money" it does not require the apparatus of the state. In a primitive society where individuals knew the members of their small social unit it is highly likely that borrowing and lending took place along with barter transactions even before weights and measures existed.

This means that the strategic actions a government, a bank and an individual can take with respect to the creation and destruction of money and money substitutes are all different.

Often overlooked in every day life are the important trading technology desiderata which played a critical role in the evolution of the money and credit system as we know it today. A good money should have the properties of:

- Divisibility;
- Durability;
- Fungibility;
- Portability and
- Cognizability.

These physical properties were well covered by Jevons.

A debatable property of a money is that it should be anonymous, i.e., it should leave no paper trail. It is a bearer instrument. Most drug smugglers are fully in accord with the existence of the United States $100 bill. The drug enforcement agencies and the tax collectors would prefer a fiat money which exists only as a computer entry rather than as paper where a million dollars in stacks of $100 bills can be packed into a standard financial paper attache case and weighs less than thirty pounds.

In addition a money should be difficult to counterfeit or debase. Furthermore it should be easy to control the processes for its manufacture and destruction.

As a rule of thumb in a society which uses a commodity money, size and weight considerations are important. A way to solve the payment size problems is to use different metals for three types of coins. Thus historically we find that copper coins have been used for small payments such as buying a loaf of bread; silver for middling payments such as buying a table and gold for large payments such as buying a house.[9] The Swedes on one occasion attempted to use copper as the basic means of payment with the result that wagon loads of copper coin were required to buy a house. At the other extreme if one tried to mint gold coins small enough to pay for a loaf of bread they would be so small that they would be impractical.

Bars of salt, measures of grain or bricks of tea

In history many different commodities have been utilized as a money. In Babylon grain was utilized as a means of payment; in Japan, rice; in some concentration camps cigarettes were currency; in Outer Mongolia bricks of tea were utilized. Mention of these historical means of payment is merely to call our attention to the distinction between a durable and a storable consumable as a means of payment.[10] The technology of production, storage and standardization all conspire against the use of a storable consumable in a modern state. When used as money the consumption of a desirable consumable is delayed. An advanced society that trusts its government is better off eating the rice or barley and substituting a symbol for them. It should want its money to have no intrinsic worth.[11]

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[9] It is well known that in an economy with freely forming prices the use of more than one commodity as a money poses problems in the maintenance of a fixed ratio in prices between the different monetary metals.

[10]The distinction between a commodity money and a storable consumable money raises some problems in the concept of the stream of services derived from a consumer durable. Does a bracelet of gold coins worn on the arm yield consumer satisfaction when on the arm, but not in the safe or under the mattress?

[11]If the system dynamics is successful in establishing a worth for the fiat money then under some circumstances individuals will create symbols of the symbol in order to preserve the "real fiat money" as a store

The static analysis of the general equilibrium theory of price has no money in its exposition. Because it provides an existence proof for efficient prices in the economy, but it does not provide a process analysis, it kills both the role of time and money in its solution in parallel of all economic activity.[12]

Gold and value-for-value transactions

There are historical indications that gold has been used in transactions for well over three thousand years. It possibly comes the closest of all commodities to being an ideal monetary commodity when one goes down the list of desirable properties for a money, noted above. It is by no means perfect. There is somewhat more than 100,000 metric tons of gold which has been mined and it is a plentiful element in the earth, but most of it is in the sea and is highly expensive to extract. Some governments historically have taken control of gold and silver mines as is evinced by the slave worked silver mines of the Athenians and the Spaniards. But the production of precious metals has tended to be costly and the ability of a single government to police the flows of precious metals across its borders has always been imperfect.

A reason for an individual to prefer gold as a currency over fiat money was already observed by Ricardo. It amounted to the proposition that trust in gold as a currency is easier than trust in the politicians and bankers who are meant to control the fiat money supply.

Fiat Money

Fiat money is a creation of the state. It is an imaginary commodity substitute for a durable commodity money.

The growth of world trade and population has made gold even less suitable as a currency than it was in the nineteenth century. Furthermore the growth of enforceable commercial codes together with reasonably democratic societies whose governments are somewhat controlled and trusted by their citizens, when combined with the development of computers and communication nets have produced the conditions for the utilization of an abstract fiat money as a substitute for a physical commodity.

When we review the desirable qualities of a money the perfect money is a total abstraction; pure information stored in a computer system whose operators can be trusted. It is easily transported at the speed of light, it does not tarnish, it does not rust, it is easily divisible But there are problems with the guardians of the information system although advocates of e-commerce claim that their transactions are anonymous. Economic anonymity in one context may not be social or political anonymity in another context. One's worries about Big Brother or new sources of consumer surveys and tax information

It is usual to contrast fiat money with a commodity money in terms of the former having the store of value property purely through the bootstrap of the dynamics of expectations, whereas the

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of value while burning the imitation fiat money to help the spirits of the dead.

[12]In game theoretic terms all individuals simultaneously announce a complete strategy for all periods and a simultaneous calculation is made to obtain equilibrium prices. All credit is implicitly granted and as all books balance at the end of the economy all loans are assumed to be paid back. All individuals implicitly trust each other, there are no transactions lags, government money is not needed, clearing houses are costless and timeless and there is no float.

latter has an intrinsic store of value in its use in consumption or production. This dichotomy is by no means clean. In fact, in spite of the ideal condition that a trade utilizing an ideal commodity money should be intrinsic value for value, historically gold has usually carried a transactions value premium; i.e., there are individuals around who have no consumption desire for gold but who value it for its services as a means of payment. This observation can be made mathematically rigorous.[13]

Credit, fiat and contracts: Inside and outside money

In this section credit is contrasted with fiat money. From one point of view both credit and fiat money appear to be contracts and as such they involve at least two parties. But when we view the role of the strategic relationship of the state and the individual as contrasted with the relationship between two individuals or even an individual and a bank, the importance of the disparity between the powers of the individual and the state or a financial institution is brought into view. Quantitative differences, if large enough, may manifest qualitative differences. So it is with the monetary relationship between the individual and the state. When Mr Jones is owed $10,000 by Mr Smith he has (or should have, if he has any sense) a legal contract, in general with a due date. When the date for repayment is due, Mr. Smith repays, goes bankrupt or renegotiates. If he repays both sides of the debt contract are destroyed. An asset is removed from one balance sheet and a liability from another. If Mr Jones owns an asset called $10, 000 in the form of a hundred $100 bills, he may think that he has a contract with the government which somehow owes him something. If he goes down to a branch of the Federal Reserve Bank he may be able to exchange the bills for nice new $100 bills because they are fungible. But he might as well save himself the gymnastics because what he owns is an asset like gold, except that its store of value property is mainly derived from the dynamics and not partially derived from intrinsic value and partially derived from the dynamics.

The non-symmetry in size between the individual and the government makes it meaningful, from the point of view of economics and finance to regard the government as outside of the private enterprise economy which may regarded as " game played by private individuals and institutions."

From the point of view of society and the polity, the government is indeed part of the game. But the time spans for action by the government are different and longer than most economic activity. The economic agent may regard the government as the creator and the keeper of the rules of the economic game.[14] When the financial accounting is to be performed for the economy as a

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[13]The condition of enough money is characterized both by the total amount of money in the system and its distribution (taking the transactions technology as given). We specify the three conditions concerning the sufficiency and distribution of money.

Enough money, well distributed An economy will have enough money that is well distributed if at any equilibrium no individual experiences a cash flow constraint.

Enough money, badly distributed An economy will have enough money that is badly distributed if it is possible to redistribute the money such that at an equilibrium no cash flow constraint would be binding for any individual.

Not enough money An economy will not have enough money, if at an equilibrium there is no way to redistribute the money such that all individuals can avoid a cash flow constraint.

When there is not enough money in a society for a given technology the price of gold will go to a premium above its marginal consumption value. Mathematically a shadow price appears for the cash flow constraints which become binding when there is not enough money for transactions.

[14] The rules may be a complex blend of law, politics, technology and custom. Experiences with the Livre Tournoise or the Susan B Anthony dollar show the power of custom. Social acceptance, even of a coin, is not

whole it should include the accounts of the government as well as all individuals in the economy.[15] When the rules of conservation over the money supply are considered they include not only the fiat held by the public or the agents in the economy, but the fiat held by the government even though this fiat is an imaginary good. If we think of it, not as a cipher, but as paper gold or as durable Poker chips then its physical relationship to a commodity money is made clear. Fiat money can be legally destroyed or created by the government and can be accidentally destroyed (but not legally created or destroyed) by an individual. One can accidentally burn a dollar bill. Individual trust in the government depends considerably on how the government violates conservation.

The essentially nonsymmetric roles of government and individuals have resulted in an economic system in which fiat money is not manifested as a contract but as a constructive commodity or virtual asset where the individual knows he or she cannot "cash in" a dollar with the government.

Banks, insurance companies and other financial institutions are strategically far larger than the average individual and common wisdom tells us that the strategic dealing of an individual with a bank are in general not symmetric. Yet the difference in the relationship between the banks and an individual is not as radically different as it is between the individual and the government. When an individual borrows from the bank a contract is created and the individual is given a checking account in bank money, which because it is generally accepted in transactions it is regarded in public parlance as "money," where for most operational purposes it is a substitute for fiat. But the individual can call for the bank money (which in reality is the bank's IOU note, or debt) to be redeemed in fiat money.

A key aspect of the nonsymmetry between a bank and an individual is in the information network, reputation and level of due diligence required in the mechanics of borrowing from a bank. The actual act is a contractual exchange of individual debt for bank debt. But the dynamics of the information and evaluation network of the system is such that the individual debt is not an accepted means of payment, whereas the bank debt is an accepted means of payment.

Institutionally there are many other forms of debt such as credit card balances owed, pawnbroker tickets, casual loans among friends, but they are all implicit or explicit contracts and virtually all are denominated in fiat money.[16] In each instance in the creation of inside debt, the levels of trust and information may vary considerably and secured lending is utilized as a way to cut down on the need for trust, the gathering of information and expertise in evaluating the information available. The credit market can trade off the need for expertise against the possession of security or economic hostages.

The financial system must be considered holistically. One cannot study individual credit generation completely ignoring the role of the government. Even with secured lending, part of the security may come from government guarantees not individual physical assets. In a fiat money based economy various stipulations on the relationship between the amount of fiat in the hands of the public and the government can be used to control the overall supply of credit.

Although a government fully controls the supply of fiat, it does not fully control the supply of

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guaranteed.

[15]From a game theoretic point of view, over a short time period the government policy may be taken as given and the government may be treated as a strategic dummy by the individual agents. A strategic dummy, is nevertheless a player.

[16]Although this is not a logical necessity. For example in foreign lending some bonds have been denominated in gold. In casual neighborly borrowing the quart of milk borrowed is often returned in the form of another fungible quart of milk.

credit among individuals. All that is required for the extension of credit is an informal agreement or implicit contract between two individuals. Even a police state cannot police exhaustively at this level of microeconomic detail.

When we think about the money supply in the economy we usually are thinking about the aggregate of the fiat money and the credit instruments that are more or less accepted as means of payment. The government cleanly controls the first, but only loosely influences the second.

THE INITIAL CREATION OF FIAT

The basic argument here is that "some fiat money" is created by the government with no offsetting asset. Later we note that because the numeraire can be arbitrarily fixed, some money is any amount.

The amount of fiat money needed to support the economic activity of a monetary economy is "some."[17] Historically one can argue that the first fiat was a hybrid of commodity money and government power. The Lydian coinage probably was the first money with the clear imprimatur of the state marked on it.[18] It was made of Electrum and hence classifies as a commodity money, but the formal addition of the power and visibility of the state combined with the gold blends the commodity and the fiat aspects. One can and did use gold in ingot or dust form as a commodity money, well before gold was coined. The power of the state in coinage is explicitly present in standardization, in guarantees against debasement and in enforcement of weights and measures. At best these features are less explicit when trading with ingots or dust. From the very start of coinage it is doubtful if there was ever a coin which traded over many years at its pure commodity value. In some instances such as when Imperial Russia coined platinum, the coinage was undervalued and disappeared from circulation. Otherwise there was always some component of its value attributed to its use as a means of payment. It was merely a matter of time and extra sophistication for the economy to dispense with the commodity component of the fiat-commodity money which heralded the introduction of the government into the monetary economy.

Government money can enter the economy in many ways. One way is by an act of force or power with which, at least, initially it can get away. For example it can print the money and use it to pay the troops, simultaneously decreeing that the money is good in the discharge of all debts, private or public. When law and custom clash, frequently custom wins. Thus a government may get away with an initial injection of a government money, but not necessarily subsequent ones. Only "some money" that is not subject to the presence of an offsetting contract is needed. From then on it is not difficult to vary the money supply utilizing notes, bonds and taxation, as is discussed below.

After the initial injection[19], if the government unilaterally prints more money the system dynamics may inflate. In particular the faith in the store of value function of fiat will erode. Thus

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[17]The key distinction is between zero and "some" no matter how small (technically this is the difference between the closed and open set on which the amount of money is defined). The amount of fiat or outside money is nonzero. As the scale is arbitrary we can define the "some" to be any amount we wish, such as one guinea or a billion dollars.

[18]Accompanying the introduction of official coinage was seignorage which allowed the central authority to "take something off the top" as its reward for providing legal money.

[19]The initial injection makes the equation system inhomogeneous. The books can balance "at the end of time" when the system has eaten the money through an arbitrarily small additional interest rate which finances the float.

from the point of view of individual expectations it is desirable that the government have a clean non-inflationary policy which amounts to no further creation of money without an offsetting financial instrument such as a bond.

In essence, fiat money can be utilized to finance the gap between when any transaction is started and it is completed. It permits the transactions to be simultaneously strategically decoupled in the small amount of time that is required for the completion of any transaction. It is, in some sense like, but not quite the same as a one period-in-advance cash constraint. However the coverage required depends on the physical aspects of human transactions and decision-making, not on the proposition that transactions are all one period cash-in-advance.[20] Economic life involves a finite minimal utilization of time.[21]

Even in a world with electronic communications minute payment gaps exist in running the processes as can be seen by considering the Federal Wire clearing system in New York, where interest payments are now down to the minute, or CHIPS (clearing house for interbank payments system), each of which clear of the order of a trillion dollars a day.

The introduction of process requires the explicit consideration of time and the observation that decisions take a finite minimal amount of time requires the introduction of an outside or government money which behaves as a virtual commodity money and not a debt instrument.

MONEY AS A NUMERAIRE

The selection of a scale, appears to be an purely arbitrary act. But once the scale is linked to an important economic phenomenon such as bankruptcy the numeraire has economic significance, as is noted below.

As both the bankruptcy and default laws and the laws on theft and other economic crimes are denominated in the monetary unit and legal, political and social sanctions, such as jail terms, being thrown out of the club, exile or servitude, the selection of the unit has immediate consequences. A change in the monetary scale unit (or inflation) can turn a misdemeanor into a crime unless the law is also adjusted. Stealing $10 in 1850 is economically not equivalent to stealing $10 in the year 2000.

In the same way as one selects an arbitrary unit for the measurement of temperature one can select a unit for the measurement of price. The selection of a money, however enables us to achieve a considerable economy in encoding and decoding. In a crude, but often useful way we can measure wealth and taxes, each as a single number. In the dynamics of perception and the formation of economic expectations the simplification of dealing with a single number is considerable.[22] Soon after the invention of coinage the methods of taxation were influenced by the acceptance of money in the payment of taxes.

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[20]In particular when one tries to reformulate the general equilibrium model as a *process oriented model* the behavior of each individual must be decoupled so that price formation is part of the model, as contrasted with assuming the existence of price in equilibrium. The way to do this is to have trade in a commodity or fiat money. Formally this can be set up as a strategic market game.

[21]And for that matter considerations of the influence and importance of space are worth pursuing. But for brevity the role of physical space in finance is not explored here.

[22]Another example is provided by the stock market indices such as the Dow Jones Average or the cost of living index.

THE ROLE OF DEFAULT AND BANKRUPTCY

A critical distinction between fiat money and credit is that in normal[23] economic activity it is neither created not destroyed by individuals whereas credit is. Credit instruments are terminated either at the completion of the contract or by some form of default, bankruptcy and reorganization. The default and bankruptcy rules play an important role in establishing lower bounds on prices. This somewhat cryptic observations becomes clear when we contemplate the social purpose of the default laws. They constitute a fundamentally important public good which helps to determine the overall amount of risk a society is willing to absorb. The laws tie in the option of bankruptcy into individual preferences thus default becomes economically real in the sense that given the prices for resources an individual trades off the worth of buying them with credit against the probability of default and the harshness of the penalty that would be imposed.

In a society abounding in uncertainty, failure occurs through incompetence, ill fortune or dishonesty or a combination of these reasons. The issue of credit almost always involves risk. The severity of the bankruptcy laws influences the willingness of lenders to lend and borrowers to borrow. If bankruptcy laws are Draconian with death penalties, slavery or indentured servitude in the colonies; deportation to Australia or a life sentence to Old Newgate prison; essentially few, if any, will dare to borrow. If, in contrast, debts are almost always forgiven by the courts then no lender will lend as they will expect that unscrupulous borrowers will borrow and then default strategically.

In a society without random occurrences, the optimal bankruptcy rules for the society are clear. They must be harsh enough to dissuade all individuals from strategically opting for bankruptcy; but in a society with incompetence, misestimation and random events it is not always possible to distinguish ill-fortune, from incompetence or fraud.[24] The society, as a whole, by its laws and customs selects the level of failure under all circumstances it is willing to accept.[25]

When a firm or individual goes bankrupt, its resources are reallocated. There is an asset reconversion. The original credit arrangements are wiped out but **real resources and fiat money** are conserved although under a probable change in ownership.

The bankruptcy and reorganization laws of a society constitute a major public good.. Society must select the mutation rate it is willing to pay for in the tradeoff between successful new projects and aborted resources. Credit and the bankruptcy and reorganization laws provide the body economic with its means for mutation. When firms fail, society as a whole suffers from the misallocation of resources. The level of harshness of the bankruptcy laws control the risk-taking behavior of the would-be borrowers and lenders. The lighter the laws are, the more the willingness

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[23]The word "normal " is used to rule out the illegal but feasible situations such as burning a $100 bill with witnesses, memorizing its numbers and exiting across the border of a state which forbids the export of dollars, then applying to the Treasury for the issue of a new bill. This simple scenario illustrates that fiat money is an abstraction but the imperfection of human verification legally requires its physical manifestation. One can actually execute this manouevre with travelers' checks which are a form of credit.

[24]There are administrative difficulties in devising the appropriate penalties, when one counts the degrees of freedom, perfect bankruptcy laws should be individual. Society approximates this microdetail by law suits which hand-tailor the outcomes.

[25]Although if evidence of fraud can be produced the bankruptcy laws may be specially harsh as evinced by the distinction between misfortune and fraud made in the early Spanish bankruptcy rules Las Siete Partidas of Don Alfonso, the Wise.

for risk taking, by the borrowers, the more the level of innovation and the greater the level of failure.

VARYING THE MONEY SUPPLY

Given the existence of a unit of outside money, the government can adjust the money supply by a combination of taxes and the creating a new financial instrument, the bond. By selling bonds for fiat money, part of the issue of fiat is returned to the government and a government debt is created. If (as is usually the situation in a growing economy) there is a positive interest to be paid on the bonds conservation could be broken once the government had paid out, in interest, the money taken in from the sale of bonds. It earns no interest on the money removed from the public, whereas the bonds earn an interest. Taxation in general will provide the flexibility for the government to balance the books. It is at this point that economics, in general and government finance in particular confront political economy and socio-political economy. The choice of how to finance a war is more of a socio-political choice than an economic one. It has often been remarked that a "good tax" is one that it easy and cheap to collect. As taxes increase, the taxed become less docile. The politicians and administrators are thus faced with assessing the relative feasibility of paying for a war out of taxes, out of the printing presses and inflation or out of bond sales and all combinations thereof.

The government use of the money rate of interest is a strategic variable which interacts with a "real rate of interest" which can be interpreted an approximation to the overall physical growth of the economy. Classical economic theory has these two values line up in a non-inflationary equilibrium. Our concern here is not with the details of government policy, but to note that fiat money, taxes money rates of interest and bonds or national debt provide a control network on the economy sufficient to vary the money supply.

EXPECTATIONS, POLICY AND THE UPPER AND LOWER BOUNDS ON THE PRICE SYSTEM

It is hopeless to look for a unique dynamics for all politico-economic systems. The action of a skilled macro-economist with good sense is to provide, a good ad hoc model of the problem at hand combined with a feeling for the tradeoff between political feasibility and economic desirability. The underlying principles of macro-economic policy may be invariant but their application depends on a myriad of detailed features of the economy which is under consideration. This is why it makes perfectly good sense to update macroeconomic models at least annually and to re-estimate parameters as new information is obtained.

An elemental consideration of history and human behavior reinforced by an understanding of the hyper-astronomical proliferation of theoretically available strategies tells us accurate economic prediction, by its very nature must be highly constrained. However, one may be able to make useful observations on the limits on the dynamics. We discuss below why there is a variation in the velocity of money and why there must be a bound on the velocity of money, but for the moment we assume it to be fixed. Given a fixed supply of outside money, a bound on credit and a fixed velocity then there is an upper bound on the overall price level in the economy.

Given the default and bankruptcy rules, even with relatively simple assumptions about the desire to survive and the economic motives of the individuals, there is a lower bound on the overall

price level.[26]

In recent years, along with the growth of the power of computers and knowledge in the behavioral sciences there has been a growth in the running of simulation models of the economy with the emphasis on the examination of the robustness of simple behavioral rules based on habit, survival, "good-enough" and "satisficing." Simple rules are usually conditioned by a few basic inputs. What is suggested here is that clear signals concerning the government's actions on the money supply, credit restrictions and interest rates provide an important input into the formation of expectations[27] concerning the value of money. The considerations noted here cannot be seen in a static theory of price.

The economy functions within the context of the polity[28] and the polity lies within the society and all move on different time scales. Although we can offer no specific dynamics, a general consideration of behavior and a specific consideration of the institutions as supplying "the rules of the game" provide considerable bounds on to where the dynamics can lead.[29]

Individual behavior is sequential and tends to be local. In particular when decision times, communication nets and space are considered that which passes for economic optimization without context specified is local myopic optimization ignoring the more global feedbacks of the society. Local economic optimization may be consistent with many different forms of societal evolution.

INSIDE OR OUTSIDE MONEY: THE BOUNDS ON CREDIT

One of the mysteries to the layman is the relationship between the money supply and the supply of credit. In a world with some time delays in payments it is easy to construct a playable model with a fiat money which can substitute for all credit, but not vice-versa.[30]

We also could imagine one central bank which initially owns all the gold and does all individual lending and accepts deposits. Although this is technically feasible, because of space, locality and detailed knowledge of local microeconomic conditions together with expertise in risk assessment a decentralized system with independently motivated evaluators of risk, appears to be a better option than a central bureaucracy with many scarcely motivated branch banks. The Soviet Union banking experience serves as an illustration.

There are many different institutional ways in which the granting of credit by banks can be

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[26]In the standard theory of price, the level of all prices is homogeneous of order zero; i.e. a doubling of the money supply merely doubles prices and leaves the real economy the same. This ignores the information and inference aspects of the dynamics set in motion by the way the extra money enters the economy. In the standard analysis there is no clean lower bound to prices. They are defined on the open set. Here there is both a finite lower bound determined by the default rules and a finite upper bound determined by the money supply.

[27]Open mouth operations by a central banks are real, but for stability they should not be inconsistent with open market operations.

[28] We may make a formal game theory analogy to a game within a game.

[29] Many economic models do not have a well defined state space. When one is careful in defining the state space one has to invent virtually every known economic and financial institution and instrument merely to take care of the full description of the rules of the game. Static equilibrium models do not require the careful specification of boundary and initial conditions required by the models used to examine any form of dynamics.

[30]Give everyone enough "utility-gold" coins then no one will need to borrow. Technically the economy may be modeled as a side-payment game.

connected to the fiat money supply. For instance one might rule that each bank be required to hold a given percentage of fiat money against any loans made. If the fiat money supply is limited then the bank credit extension is limited. But in a highly decentralized economy everyone can become a banker in the sense of creating a credit arrangement with someone else. Furthermore changes in transactions technology easily change monetary requirements such as when two large international companies with considerable trade between themselves substitute their own computerized netting system rather than use their commercial banks.

Small international traders will still use correspondent banks and acceptances, or four party paper because if either partner fails to deliver they both need the expertise of the bankers to take legal action in a foreign jurisdiction.

The financial system provides the **perception and evaluation** devices for economic processes. At its best the government's control over the fiat money supply provides a loosely coupled control over the overall credit supply. Bubbles can occur through the over-extension of uncontrolled credit fueled by misperceived evaluations of assets bought with the credit. In some countries the presence of capital gains taxes dampens the enthusiasm of individuals from exchanging a $10,000,000 dog for two $5,000,000 cats. In countries without capital gains taxes there are fewer bounds on the creation of bubble prices.

ON THE MINIMAL TIME FOR ECONOMIC ACTIVITY

Any economic activity takes a finite amount of time and this alone is sufficient to place an upper bound on the velocity of money.

Economic theory, like other theories makes use of the technical apparatus on hand. The use of differential calculus, the drawing of continuous cost functions and the idealization of continuous processes taking place in a smoothly flowing time have been easier to work with than discrete time models with complex boundary conditions.

In general, it is a good rule of thumb that any formal model of an economy should be no more complex than necessary to answer the question at hand. Thus many problems in economics and finance, such as the risk structure of a large portfolio or the basic properties of a price system can be usefully analyzed utilizing equilibrium techniques where all action is simultaneous and there is no consideration of process. This approach is not adequate for the study of money whose very existence is dependent on process.

The closed system provided by the general equilibrium model to study prices has all individual budgets balance perfectly. It is run as though there is a global clearing house which matches all trades immediately so that all trades, even if they are sequential are treated as though they are in parallel. The system can be interpreted as being run with no outside money and with instantaneous universal inside credit.

The difficulties encountered in trying to use the standard, timeless economic models of the price controlled economy to study the properties of the monetary system are easily illustrated when one tries to build an experimental game to explore how any price system is meant to work.

The game designer quickly finds out that some form or forms of market structure, price formation mechanisms, clearinghouses, commercial codes, law and administrative procedure must be specified. All of this process detail was not needed to illustrate the static properties of prices. All of it is needed when the dynamics of a price system is to be studied.

When we try to design, even the most elementary economic process, considerations of time span cannot be avoided. How long does it take to get paper work done, how quickly can I make up my mind; how long does it take to read the contract; how much time is required to understand the contract; how much information must I assemble in order to obtain a loan?

An elementary consideration of human behavior points out the tradeoffs between speed and error. In spite of the speed of computers and communication, the human decision making system does not work that fast. The odds are the if one tries to read a contract or drink a cup of coffee in a millisecond errors will be committed.

Yet another consideration of human behavior tells us that our perceptions, expertise, desires and attention span are such that we constantly behave as aggregating disaggregating devices. We are constantly coarse graining and fine graining the information around us. Economics has invented an elaborate theory of preferences, complete with a difficult to verify or measure concept of the individual utility function. This is meant to be a function of arbitrary dimension, representing the interrelationship of our preferences for all commodities that are available for consumption. Most of us do not know how many commodities we consume and do not even have a full taxonomy over all commodities. There is no evidence that we carry around a vector of several thousand dimensions in our heads so that we can immediately work out the tradeoff between Bach recordings and baseball bats. Most of the time we are not aware of most of our potential choices and although the world as a whole runs in parallel, individually we are sequential decision makers.

MONEY, MARKETS AND LIQUIDITY

The government of a totally centralized economy may wish to use prices for comparison in its valuation of different goods. If it were bureaucratically powerful enough in its all-knowing wisdom it would only need the unit-of-account property of a money as its citizens would have no strategic freedom of choice in the receipt of the goods whose distribution it controls. In antiquity both the Egyptian and Babylonian rulers attempted price control, but there is evidence that there was local exchange and markets at prices other than those fixed by the central authority.

Money and markets appear to be intimately related. Cash in the pocket, a money which is globally accepted provides each individual with a local power of choice. The local pressure of money chasing goods forms trading networks and creates local markets which interlink with distant markets through arbitrage. Information, communication, reputation and trust provide the ingredients for the global support of the store of value of fiat and other near monies such as bank money, credit cards or e-money. But their relative economic efficiency can be judged by their market property of liquidity. The liquidity of any asset can be judged in its role in exchange in terms of:
- Scope of acceptance;
- Speed in achieving trade;
- Transactions costs and
- Influence on price.

Fiat money is the most liquid asset. Except in extreme disequilibrium[31] fiat has a greater acceptance than any other near money. Its speed in achieving a trade in a thick market is limited only by the physical minimum amount of time required for the parties in a transaction to acknowledge that the trade has been completed. A thick market, by definition[32] is one in which even

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[31]Such as a hyperinflation or where a new and socially unacceptable money is introduced.

[32]The ideal thick market is one in which any individual trader is regarded as so small that his or her

a rich individual does not move price by his or her activity alone. In economic fact even in a very large, but finite world there are few if any ideally thick markets.

THE AMOUNT OF MONEY AND VELOCITY

In the United States the Federal Reserve gathers information on the amount of fiat money and near monies that exist, classifying them by how close a substitute they are for fiat in scope and liquidity. In the United States, the GDP for 1998 was around $8.5 trillion; the amount of coinage and currency was $459.5 billion; M1 which consists of currency, travelers' checks, short term deposits and other checkable accounts was $1,097.4 billion. M2 adds in retail money market funds and small savings accounts and was $4,397 billion; M3 which includes the above plus large time deposits, Eurodollars and institutional money market funds stood at $5,997 billion. The national debt was $16,230.9 billion. The New York Federal Reserve has estimated the velocity of M1 in the years 1978–1996 as varying between 5.9–7.4 and M2 from 1.6–2.05. There are considerable empirical difficulties in obtaining good velocity estimates, and modern texts play down velocity, but velocity fluctuations appear to be substantial and are probably related to expectations in a complex way.

A quotation from Alfred Marshal is relevant:

> Petty thought that the money "sufficient for" the nation is "so much as will pay half a year's rent for all the lands of England and a quarter's rent of the Housing, for a week's expense of all the people, and about a quarter of the value of all exported commodities" (Quantulumcunque, Queries 23 and 25: see also his Political Arithmetic, ch. IX and Verbum Sapienti, Ch. VI). Locke estimated that "one-fiftieth of wages and one-fourth of the landowner's income and one-twentieth part of the broker's yearly returns in ready money will be enough to drive the trade of any country." Cantillon (A.D. 1755) after a long and subtle study, concludes that the value needed is a ninth of the total produce of the country, or, what he takes to be the same thing, a third of the rent of the land. Adam Smith has more of the skepticism of the modern age and says: "it is impossible to determine the proportion,' though `it has been computed by different authors at a fifth, at a tenth, at a twentieth and at a thirtieth part of the whole value of the annual produce."

As Adam Smith noted, the calculation of the appropriate amount of money for the economy is difficult, but for some purposes, especially given the improvements in information, computation and the gathering of economic statistics it is not out of the question. A useful way of approaching this problem is to imagine that each instrument which is used as a means of payment in any major market is described by a different color Poker chip and the domain of use and the method of production and destruction of the instrument is fully specified in each instance.

The ideal world of the tax collector would be to have all assets turn over once during the tax period so that in each period all wealth is "marked to market." This would wipe out creative accounting. Undisclosed wealth and disclosed wealth would coincide (except for the valuation of individual talent). The world would be an easier place for the economic theorist and if all trade were simultaneous the amount of money required to run the private sector would equal the total physical wealth (leaving out the human capital) and the velocity of the money would be one.

The world is far from perfect. The network of payments is far more complex than in the time of Adam Smith yet the means for observing and measuring the flows are better. Once one is willing to consider the physical approximations of the transactions structure and understand how it depends

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actions alone will not cause a change from current price. Mathematically the individual is regarded as a set of measure zero.

on both technology, custom and the laws of the society "how much money is needed?" is a meaningful question of operational value to every central bank.

Although the full settlement of taxes comes once a year and wages may be paid daily, once a week or once a month, much of economic activity takes place in event-time not clock- time.[33] Many economic activities take place when the time is ripe, not when it is January 31 or some other fixed date. Because different individuals have some but, by no means complete control over when they sell stock or a house or when they pay their tailor the velocity of money can vary. Thus the control problem is far worse than in situations where payments are forced to be at a specific time by the rigid relationship to others in the economic net. It is the combination of this freedom combined with the possibility of a fluctuation in expectations that can turn a mass of individuals loosely correlated in their transactions behavior into a highly polarized group. This can cause considerable fluctuations in payments velocity and in prices.

The smooth world of continuous time and instantaneous payment apparently has fiat money disappear as it reaches infinite velocity. But in reality there is a minimal finite unit of time for any economic activity and even in a hyperinflation with the government running the presses the system collapses as the confidence in the worthless commodity goes to zero long before some finite bound in the velocity is reached.

GROWTH, FISCAL POLICY AND THE RATES OF INTEREST

No government controls *the rate of interest*. There are many rates of interest and the government at best controls only the short term fiat money rate. As it tends to be the largest economic agent in the economy a change in its interest rate will set off a chain of reactions reflected in the many other rates extant in the economy.

If the economy is growing , for a given velocity of money and fixed transactions technology it will need more money. Milton Friedman suggested that the amount of outside money in the hands of the public should grow at a few percent per annum reflecting the growth rate. This can be achieved with a concomitant growth of the national debt.

Leaving aside interest rate adjustments due to asymmetric information, transactions costs and a myriad of institutional details; economists are more or less in agreement that the money rate of interest in a noninflationary economy which has a real goods growth rate[34] of say, 4 percent per annum should be 4 percent. In a stationary flow equilibrium this seems to be reasonable, but once one considers disequilibrium there is an open debate concerning causality. Does the increase in the money supply foster the growth or vice-versa? The jury is by no means in yet. The government control of the fiat money supply, short term central bank interest rate and size and financing of the national debt all provide a control system over the whole economy but it is a loosely linked control

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[33]The problems with event time or clock time provide another example where the availability of technique limits the type of analysis. For the most part in economic theory there has been a choice between differential equation formulations (used heavily in finance) or difference equation formulations used with many dynamic programming applications. Many economic phenomena are best modeled as stochastic difference-differential equations reflecting an overlay of occasional events on continuous time. In general these are too difficult to analyze and hence are not used.

[34]The definition of the growth rate involves mapping a vector of growths onto a single scalar and making strong assumptions about population growth or the nature of preferences or both. At this level of exposition these difficulties are not discussed.

system which depends in detail on the socio-politics of the society at any instance of time. This determines the "doability" of any policy and the time lags in its execution. Government control in a market economy is reminiscent of the croquet game in Alice-in-Wonderland. The balls were hedgehogs, which when they tired of being rolled up, stretched out and walked away; the mallets were flamingoes who might or might not keep their necks straight when being used.

One might wonder if a loosely coupled system is better than nothing. I suggest that the answer is yes. The government apparatus serves as a single information and communication focal point and a clear policy, bounds individual expectations, even in the dynamics of disequilibrium.[35]

The economy is the servant of the society and society requires many public goods such as the courts, defense, public monuments and parks and many others. Depending upon one's political preferences and social beliefs one can argue as to what public good should be privatized or supplied by the government. For most modern states the size of the government sector appears to lie somewhere between 15 to 45% of the economy. Even if it were only as low as 10% the message would still be clear that when both monetary and fiscal policy are considered even though much of the government's influence is diffuse it is large when compared with any other economic agents.

A DISCLAIMER ON INTERNATIONAL ECONOMICS

This essay is written as though the world were one unified socio-political economy. Practical policy is vastly complicated by the presence of several hundred nation states and many thousands of tax districts together with a lack of a universally enforced set of commercial codes, bankruptcy codes, immigration rules and so forth. The rules of monetary manipulation of an individual fiat money differ from country to country and these differences influence individual policy through international trade and the movement of population. At the level of abstraction of this discussion I suggest, however that no new basic concepts appear when these extra considerations are taken into account. The complexity of policy increases and individual control weakens. Topics such as "an optimal single currency zone" emerge as examples of the trade off between local and global economic, political and societal considerations. These problems, so important to immediate policy, are not considered further here.

CLOSED AND OPEN SYSTEMS: BIRTH, DEATH AND REAL AND LEGAL PERSONS

A distinction must be made among three basically different models of economic systems. They are:
- Timeless closed equilibrium systems.
- Systems embedded in time, but studied only for their steady state equilibria.
- Dynamic systems studied for process, regardless of global equilibrium concerns.

The first type of system is typified by the general equilibrium models of a closed economy where all feedbacks among all agents are specified, there is a specific beginning and end to time and there is no outside energy input into the system.

The second type of system may be characterized by an overlapping generations model where there is a birth-death process, but in most micro-economic models the birth-death process is partially or fully exogenous to the model; the demographics is given from the outside, as are the inheritance

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[35]The key problem is for the policy to provide a bounded state space which most of the time will prevent swings in expectations from destroying the economy. The swings in disequilibrium will remain within bounds.

and other rules needed to link the generations. Once more the concern is with equilibrium, but in this instance because of the openness of the system to time, the equilibrium describes a stationary flow.

The third type of model calls for a full process description of all states that a system can reach without regard for equilibrium. This is more congenial with simulation studies where one may consider entry and exit into competition to be endogenously determined. This is close to the type of Darwinian or bio-economics envisioned by Alfred Marshall.

In modern societies there are two types of legal persons; natural persons and corporations. Their biology is different; the bigger and older the corporation is, the more likely it will live another year. Its mating and reproduction rules are different from natural persons. In law the corporation need never die, in historical fact only a few have survived more than a few hundred years.[36] But in spite of the two categories of economic decision-makers, the natural persons are the atoms of the system; the corporate persons may be owned by groups of natural persons and are made up of configurations of the natural persons. This influences the financial structure. In particular it leads to a consideration of shares, the nature of economic optimization by legal persons and the introduction of stock-markets. Furthermore, under uncertainty it raises basic questions as to what should be the goals of corporation and in whose favor should it act.[37] With uncertainty and the corporate form the easy story about profit optimization and efficiency disappears and at best we may need to settle for measures of comparative efficiency among different institutions and market structures.

SUMMARY REMARKS

My original intention was to entitle this discussion" the theory of money and financial institutions" as it is about dynamics and the institutions such as markets, commercial banks and insurance companies are parts of the rules of the game. They provide the mechanism for the carrying of process. However the central theme here is an overview of the role of money and the institutions are incidental to this theme.

A recapitulation of the basic points is as follows:

- All financial instruments except fiat money are created with an offsetting instrument or asset. This is shown in essence by double entry bookkeeping.
- The value and transactions properties of a fiat money emerge as properties of a dynamic economic system.
- It is a strategic decoupling device which provides the extra degree of freedom to permit the functioning of a price system in disequilibrium.
- The store of value property of fiat money is a phenomenon dependent on the formation of expectations.[38]

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[36]They have been primarily religious establishments, universities and other not-for-profits.

[37] The voting structure of the corporation is closer to administrative and political decision-making than it is to market decision-making as is seen by the considerable arbitrage opportunities in corporate take-overs. Even with a large body of law against corporate self-serving the stock markets and takeover markets provide only an imperfect approximation of an efficient market. Mathematically, a cooperative game representation of an economy with stockholders and firms should have a core. The conditions required for this to be so are somewhat counterfactual. The opportunities for corporate managements and board to be self-serving are difficult to control.

[38]It can be regarded as dynamic boot strapping result.

- At its simplest fiat money is like a physical asset with no offsetting financial instrument needed, a virtual gold where in a world with a nonzero interest rate it finances the time gap in transactions and is consumed by the end of time.
- Fiat money could substitute for credit, but credit cannot totally substitute for fiat money.
- In a modern economy expectations are a mass heterogeneous economic and financial market phenomenon with an important socio-political component of expectations focused on the government and administrative structures of the society.
- Even given a fixed velocity of money, the amount of money needed to run an economy efficiently is difficult to measure, but it can be reasonably approximated.
- The velocity of money is variable and this variation is highly related to expectations and the strategic independence of individual economic agents. There is a finite upper bound to velocity beyond which the organized financial structure will be destroyed.
- The bankruptcy laws constitute a public good which influences the risk-taking and innovation rate of the economy.
- The bankruptcy laws tie the worth of default into the preferences of individuals and thereby link strategic bankruptcy to the price system. If the bankruptcy laws are given and prices are low enough it pays to go bankrupt.
- Any economic process requires a minimum finite amount of time for completion. There is a trade off between the compression of time and the generation of error. The presence of a minimum quantum of economic decision time rules out an infinite velocity for money and places a lower bound on the quantity of money needed in the system.

AN APPENDIX ON UNCERTAINTY, FIAT, BANKRUPTCY
AND THE RATE OF INTEREST

As these comments are somewhat cryptic and technical, based on ongoing work of Karatzas, Shubik and Sudderth they are made in an appendix merely to go on record that in a complex economy with many stochastic elements even the concept of the existence of any reasonable form of stationary equilibrium may be suspect.

In a stationary economy with a fixed fiat money supply and exogenous uncertainty at the level of individual income, with no loan markets, fiat money would be hoarded by individuals as a store of value. If an inside money market or a central bank making loans and accepting deposits[39] were to exist, even without transactions costs, they would go active but would have to have a differential in the ex ante borrowing and lending rates in order to cover to possibility of default by the borrowers while conserving money in the overall system.

The wealth distribution of individuals appears to be a function of an intermix of skill and luck. Under relatively simplistic assumptions it can be shown to be stationary;[40] i.e., one would expect that a stable distribution of wealth would emerge. Unfortunately in an economy with several sources of uninsurable uncertainty the very existence of stationary equilibria is not clear.[41]

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[39]In general, central banks do not accept direct deposits from the public because it makes better administrative and informational sense to leave local borrowing and lending to specialized groups set up to process the more locally relevant information. Abstracting away from this observation, if the overall money supply does not need to be changed then either an outside bank accepting deposits and making loans or a money market are interchangeable.

[40] This amounts to showing the existence of a complete distribution of wealth which as a whole maps into itself under the given policies of the agents, but the wealth of the individual agents may change.

[41] Furthermore in a stationary growth economy without uncertainty, if the money supply and growth rate are equal the system is non-inflationary or non-deflationary, however if there is uncertainty the economy as a whole may show an inflationary tendency.