

Money and the Monetization of Credit

M. Shubik*

1. Introduction

In Utopia all greed for money was entirely removed with the use of money. What a mass of troubles was then cut away!... Who does not know that fear, anxiety, worries, toils and sleepless nights will also perish at the same time as money? What is more, poverty, which alone money seemed to make poor, forthwith would itself dwindle and disappear if money were entirely done away with everywhere.

Thomas Moore, *Utopia*, Book II. P. 149.

What are the basic distinctions among a money, a near money and a money substitute? When is an individual's IOU note as good as cash? Under what circumstances can an economy get along without a governmental issue of money? What does the economy described in Saint Thomas Moore's *Utopia* have in common with the Arrow–Debreu treatment of the competitive economy?

Where does information, knowledge, “know who” and expertise play a role in monetary economic theory? How accurate is our knowledge of individual wealth? When and how does it serve to back credit? What is credit and what role does it play in the functioning of markets?

The goal in this essay is to consider and discuss these questions and to consider how a measure of the degree of monetization of the potential credit in any economy might be constructed. An attempt at mathematization is left for separate work, however a simple example is presented in the appendix and some crude statistics are presented in support of this approach.

Goodhart [1998] in a stimulating article discusses the very different approaches to the existence of money between the cartalists who stress the power of the state and those who stress the private sector (he chooses the appellation “Mengerian”) market oriented response to minimizing transactions costs. It is my belief that both of these approaches have a large element of truth in the development of a government money and large institutional near-monies and credit facilities. The unifying theme is the role of networks and information combined with custom and law for enforcement.

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2. Money, Goods, Markets, People and Market Mechanisms

The Congress shall have Power To lay and collect Taxes...
To borrow Money on the credit of the United States;...
To coin Money, ...
To provide for the Punishment of counterfeiting the Securities and current coin of the United States;
To establish Post Offices and Post Roads;
Excerpts from Article I of the Constitution of the United States

The competitive equilibrium analysis of the price system concentrates on goods, individuals and firms as the primitive concepts with the endowment of goods given. The existence of an equilibrium set of prices is established. Total trust or a timeless trade is implicitly assumed. The strategic market game approach [Shubik, 1999] differs from that of the competitive equilibrium in the introduction of an explicit role for money and for markets as price formation mechanisms. The stress is on process, mechanism and a playable game. A playable game requires rules and the rules are a product of both custom and law.

A useful way to consider money, markets and market mechanisms is as follows. Represent any good or financial instrument by a point. An arc connecting any two points may be regarded as a market. At a finer level of detail there is a black box associated with each arc which contains a market mechanism which specifies precisely how price is formed in that market. A commodity or paper financial instrument serves as a money if it has arcs which connect to all other points. Figures 1a, b, c and d illustrate an economy with 4 goods and 0, 1, 2 and 4 monies.

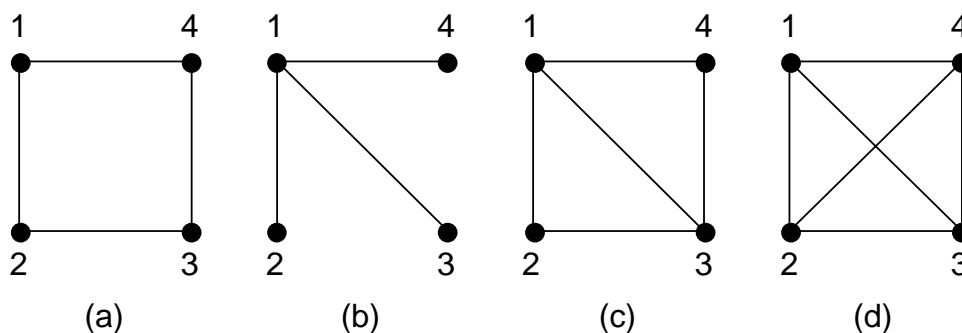


Figure 1

The “black box” contains the specific details of the market institutions and clearing devices. Thus, for example, details concerning whether a specific market utilizes a double auction mechanism and has a clearinghouse attached are in the black box. Dubey, Mas-Colell and Shubik [1980] showed that with a continuum of agents the details concerning the specifics of mechanism could be ignored at equilibrium. When the continuous approximation to the finite number of agents cannot be justified, mechanism matters.

When discussing the money supply the term “near money” is often used to refer to a financial instrument which will be accepted as a means of payment in almost all transactions. Thus a check drawn on a well known and reputable bank or a major credit card may serve as a near money.

A money substitute is an instrument such as a gasoline or department store credit card which substitutes in the short term (often 30 days) for a cash payment in a specific market.

A somewhat difficult question is how small a community can support a money. There are instances where prisoners have utilized cigarettes, or towns or special communes have issued their own currencies based on labor units or on redemption in the national currency. But they tend to depend on the specifics of the structure of the environment in which they are embedded and tend to be highly transient. In particular they tend to be special communities within and dependent on a larger ongoing society.¹

3. Credit, Information and Networks

In essence inside all money is credit. Fiat money is an asset, a paper gold.² “Credo” or “I believe” is essential to the successful acceptance of any money or near money. Trust and belief are critical. In turn they depend on the social and individual evaluation of information leading to reputation.. Information is highly influenced by three basic factors. They are: 1. space, 2. time and 3. network connections and visibility.

Much of human behavior is local both in time and space. The growth of communication methods have reinforced the importance of an information net connection which overcomes physical distance. Every individual has a “know-who network.” In 1700 immigrants to the United States had friends and family in “the old country” and to some extent were in contact with them by sea mail or by a rare ocean voyage. The telegraph, the telephone and now the web have radically changed the importance of space in message communication. In a less radical manner physical space has been shrunk by the railway, the automobile and the jet aircraft. Yet for much of day-to-day life physical distance is a critical consideration.

In traveling, for example, in spite of being able to see pictures of a hotel, or reproduction of a menu this information is a poor substitute for knowing someone whose judgement you trust, who knows your tastes and has stayed frequently in the hotel and eaten

¹See a recent example of the issue of the simec by Professor Auriti in Guardiagrele, Italy reported in the *New York Times*, January 30, 2001 by J. Tagliabue.

²All credit has an offset; but some injections of government money need not have an offset (other than force or guile). Fiat money is not redeemable, it is an asset like gold and may have no offsetting instrument. The financial system as a whole may be nonsymmetric. It does not need to net to zero; but under appropriate conditions it can be shown that in an infinite horizon stationary state the economy is cash consuming and in the limit, symmetry is approached (see Shubik, 1999, Chs. 11 and 15), The nonsymmetry is a feature of the dynamics and is related to the financing of the float and the selection of the numeraire and bankruptcy penalties.

at the restaurant in question. Locality both in space and time are still critical in the micro-micro-economics of evaluation.

The influence of modern communication has, for many purposes, elevated the *network* to a level of importance on par with space and time. In particular the network is emerging as a key feature in the financial world and in the evolution and evaluation of credit. For some purposes of communication the appropriate measure of distance is no longer a linear measure but the number of nodes in a communication net connecting *A* to *B*. In some instances the symmetry or lack of symmetry in the strength of the connection *A* to *B* or *B* to *A* may be of importance. A “know-who net” between friends or family may tend to be symmetric. But the relationship between a government agency and a private citizen or between two individuals at different levels in a hierarchy is nonsymmetric.

A useful way to look at the individual is as an entity belonging to several different nets which serve different purposes, such as family, friends, professional, religious, economic and political. Depending on the stimulus and activity the individual agent’s attention and activity switches among these nets. For the most part organizations are devoted primarily to only one of these purposes.

3.1. Fiduciaries, Intermediaries and Instruments

Most economic decisions are made by fiduciaries. The decisions are based on informal or formal group actions. Even most of consumer decisions are made by one member of the family buying for the family. Family saving (which can be regarded as passive lending) and family financial investment is heavily in mutual funds and pension funds where the individuals and families are passive investors having implicitly if not explicitly acknowledged their lack of competence in investing directly except in durables such as houses, automobiles and other consumer durables.

The intermediaries offer aggregation of funds, efficient transactions, expertise, and supervision of portfolios. Except for a small part of the saving population who are rich or sophisticated or both, the savers or “passive investors” are served by mass market standardized financial products. The financially small investor may own a nonstandardized financial instrument if he invests in his brother-in-law’s new firm or his close friend’s business or if he is being hoodwinked into a fraudulent IPO.

When she procures a large loan such as a mortgage the homeowner signs a legal document more or less standardized by the state, but possibly adjusted by the lawyers and “personalized” with the specification of the property in question. The mortgage may be flowed through in a large package of mortgages to be cut up, wrapped into special groups and sold independently much like processed chicken in the supermarket. Drum sticks or long maturities here; wings or a high risk package there. At this stage both the mortgage and the chicken have lost their individuality.

By far the largest primary financial markets are for instruments being sold by financial and/or nonfinancial corporate fiduciaries to each other. Here the rule is that the larger the transaction, the more complex and nonstandardized and the more frequent the dealings

between the agents the more likely the transaction will be face to face, not via a mass anonymous market. The trade will be a hand-tailored transaction with a highly specific information content, even though the package may involve fungible instruments such as bonds and stock of both parties.

The concepts of anonymity and fungibility depend on social, legal and political context and the fineness of perception. The most anonymous of means of payment is a cash payment with no receipt and no witnesses. In the context of everyday business a payment by check or credit card is, in essence, anonymous. It is not anonymous from the point of view of leaving a “paper trail” to track down illicit trade or socially unacceptable behavior, nor is it anonymous if it is utilized in customer lists or credit card payment credit evaluations.

The competitive market functions the best under mass anonymous transactions (see the axioms of Dubey, Mas-Colell and Shubik [1980]), yet the credit markets function best with the availability of an analyzed dossier on each individual. When there are masses of individuals to be serviced for credit standing, the personal touch of the local banker will be replaced by some form of more or less automated scoring system. Furthermore in economic transactions involving only a few years the commercial code, the laws of contract and the force of custom are givens. This includes the power to enforce and to punish violation.

3.2. Family, Friends and Finance

The sociological phrase “6 degrees of separation” refers to the feature of human communication networks that there is probably a “know who” network with no more than six links which can connect any two individuals on the globe.³ More important than the existence of a tenuous web of links is how the links are reinforced to produce a solid connection which may lead to new behavior and a modified or new institution. Both frequency and intensity conspire to “thicken” or solidify the social and economic connections. A good example is provided by the history of many merchant bankers (see Wechsberg [1966] for an entertaining popular description). An individual in opening a retail establishment builds up a far larger net than he might have purely socially. If he is a good merchant he will have many repeat customers (thickening of the links) and will be able to assess how to grant his customers credit. As his reputation grows and his assessments of credit granting turn out to be profitable he may expand his lending beyond consumption loans and may give up his nonfinancial activities.

In general private individuals and single proprietors do not have a sufficient number of links, a large enough reputation or the credit assessment ability and resources to be able to go heavily into the credit granting business. If they lend at all it is not their IOU notes that they lend but whatever bank credit or government money they possess. Good collateral is an effective substitute for individual credit assessment. This is why a single individual with little initial capital, who is able to do a reasonable job on evaluating objects for pawn and

³If each knew the same number of individuals in a tree or hierarchy structure one would only require a little more than 1800 connections

lends only a fraction of their discounted worth, can become a pawnbroker.

Physical force is also a substitute for the need for credit assessment; the numbers racket seller may extend credit to some of his gamblers knowing that his enforcers provide a sufficient threat that he will be repaid.⁴ Legitimized force plays its role in the governmentally specified rules governing trade and the economy.

Individuals who are famous or notorious, such as movie stars, pop singers, baseball players, some billionaires, top politicians or Mafia family leaders have extremely large “know who” nets but the nets are essentially all unidirectional and the reinforcement is unidirectional, i.e., anonymous individual A knows the star and may learn more about her, but the star knows nothing whatsoever about the individual. This net has economic value to the celebrity, it may be used as a source of credit and she can become an avenue of transmission in advertising and public relations.

An estimate of the lower and upper bounds on the size of the individual “know-who” net for most individuals is of the order of $4,000 \pm 1,000$. The guesses are constructed from my own information and informal discussions with friends. Somewhere between 500 – 5000 links per individual has been suggested by Charles Kadushin [2000] elsewhere.⁵ The questions raised by the attempt to describe the net are regarded as more important than the numbers guessed. The reader is urged to construct his or her own estimates. There are studies in sociology by Milgram [1967], Granovetter [1973], Boissevain [1974], relevant to this. It is unlikely that anyone has exceeded acquaintanceship with more than 25,000 individuals whose names and faces he recognizes and who know him.

Considering only the individual’s economic life, we divide it into consumption and production segments. Thus the economic “know-who” net consists of stores, tradesmen, medical facilities, brokers, banks, employers and others who, for most individuals are at most a few hundred. Much of the network data concerning economic institutions either does not exist in a form utilizable for this discussion or does not exist at all. We can hazard guesses and hope that the case can be made for the eventual gathering of this type of information (see White [2001], forthcoming⁶).

3.3. Credit Evaluation

Money and credit are based on an intermix of information, trust and power. In particular, for the most part the relationship between a borrower and lender; the insurer and

⁴There is a popular dialogue worth noting. COLLECTOR: Pay up! DEBTOR: I cannot pay, I have no money, it is like trying to get blood from a stone. COLLECTOR: What makes you think that you are a stone?

⁵Website reference.

⁶Just before this paper was fully finished I visited Harrison White and had the pleasure of obtaining the file set for his forthcoming book on Markets from Networks. Although his stress is on production rather than consumption or finance, the approach is allied to the discussion here.

the insured or the customer and the department store is nonsymmetric. The individual chooses the bank or a major store through some combination of reputation, location and chance and establishes a more-than-one-time relationship by experience. The reputation of an ordinary citizen or small business is not immediately known to the large institution. It must rely on some form of information gathering and evaluation. Since the 1950s in the United States the techniques of quantitative methods in credit evaluation and management have increased considerably (see Rosenberg and Gleit [1994]) along with the growth of consulting and specialist credit evaluation firms such as Fair Isaac Company and credit bureaus such as Equifax, Experion (UK) and Transunion.

Much of the mass credit evaluation is for consumer credit associated with the various types of credit cards available. The old 3-C's of commercial banking, "*Character, Competence and Collateral*" are expanded and specialized.

An estimate of the cost of a mass consumer credit assessment may be somewhere between 5–25 cents per capita depending on sample size, frequency of updating (such as 6 times a year for some credit cards), with many billions of credit decisions per annum. based on these evaluations. The borrowing limit is for the most part below \$15,000. Different estimates can be made by a credit company both concerning the credit-worthiness and the potential profitability of a cardholder. A private individual in 2001 could obtain his or her own credit profile commercially for \$12.95.

The automated evaluation programs have recently been extended into small business lending where the sums may be as high as \$500,000. As the individual amounts borrowed become larger the evaluation process becomes less anonymous and more hand-tailored. A due diligence study of a firm in a merger or acquisition can easily involve many millions in accounting, legal and investment banking fees.⁷

Credit assessment may be done by scoring procedures, but also much of it comes about as a byproduct of contractual relationships of varying force. An individual in opening either a bank account or a broker's account enters into a contract and after a few years a "track record" is more or less established.

4. Some Crude Statistics on the Communications Structure of Trade and Credit

Some crude figures concerning the network and geographical structure of individuals and economic activity are given. The estimates come primarily from the 1999 Statistical Abstract of the United States.

4.1. The Agents to Be Distinguished and Some Magnitudes

The population of the United States in 1996 was approximately 270,300,000 and in 1998 was composed of around 102,500,000 household units averaging 2.62 persons per unit

⁷A rough estimate can be obtained from observing that the investment banks in the United States earned around \$12 billion in 2000 for around 4,000 deals.

with around 200,000,000 voters (SAUS, 490). Essentially all of these units contained some member who recognized the existence of the government of the United States and its power and reputation. Most households have individuals who recognize their state government and some (but not too many) may know the name of the mayor or an alderman in the town in which they dwell.

In 1996 there were 4,631,000 corporations, 1,654,000 partnerships and 16,956,000 individual nonfarm proprietorships (SAUS, Table 861). Among the corporations 841,000 had receipts of over a million dollars and accounted for a little under 95% of the total receipts of \$14,890 billion. The top 80,000 partnerships had receipts of over a million dollars and accounted for 88 % of receipts of \$1,042 billion. The top 71,000 proprietorships accounted for only 19% of receipts of \$844 billion. Averaging over all members the size ratios of corporations: partnerships: proprietorships was 68: 13: 1. The size spread among the institutions which accounted for 95% of all trade is far larger.

An indication of the financial size of the government sector is given by their revenues and expenditures. In 1996 when GNP was \$7,674 billion (SAUS, 727):

The Federal government revenues and expenditures were \$1,573 billion and \$1,705 billion.

State government revenues and expenditures were \$967 billion and \$860 billion.

Local governments revenues and expenditures were \$804 billion and \$794 billion.

Dividing group income by the size of the group and normalizing so that the size of the individual income is 1 we obtain a rough comparison of financial size in Table 1.

Table 1

| | Numbers | Expenditure | Unit finance size | Size |
|------------|----------------|--------------------|--------------------------|-------------|
| Fed | 1 | 1.57E+12 | 1.57E+12 | 55,387,324 |
| States | 50 | 9.67E+11 | 1.93E+10 | 680,986 |
| Local | 85,000 | 8.04E+11 | 9.46E+06 | 333 |
| Individual | 270e6 | 7.66E+12 | 2.84E+04 | 1 |

The Federal government weighs in as around the income of 55,000,000 individuals while the state governments on the average are around 680,000. Together all levels of government expenditures are more than 40% of GNP.

The sizes of distributors and wholesalers relative to population was approximately 1: 170: 520, while for banks in the USA it was 1: 30,700. Averages are frequently misleading, but for brevity and consistency it is worth giving them with the warning as to where the worst distortion is located. For example, although there may be several stock markets in the US as a good approximation only two account for over 90% of the trade by any measure. Furthermore for virtually all of the financial institutions the top ten account for a considerable percentage of the economic activity.

4.2. Space

The land size of the United States is around 3,536,300 square miles. It has existed as an independent country since 1776 or for 225 years. In 1996 the number of Metropolitan Statistical Areas (MSA) in the United States was 274 with an aggregate population of 211,900,000 or around 79% (SAUS, Table 40). 91,000,000 lived in the top 12 metropolitan areas in 1997. Much of day to day living is local, although the Web is making inroads into retailing and financial markets are more and more Web phenomena. Where we live matters considerably in social, political, work and general economic life.

4.4. Financial Institutions, Intermediation and Information

Any competent text on financial institutions notes the important functions of intermediation and lists various reasons for intermediation. These include: 1. aggregation and pooling, 2. divisibility, 3. flexibility in maturity, 4. greater liquidity and 5. good accounting. These services are provided by size, expertise, location and network connections.

The financial processes are as much production processes of an economy as is the manufacture of steel. Although it is true that much of information, once produced can be replicated easily, for example a song or a lecture can be tape-recorded many times at little cost, thus the analogy between a normal consumer or producer good and information may be poor. This however is not so for many of the purposes of credit evaluation. A credit evaluation is not unlike a driver's licence or a license plate. They are products with network acceptance.

The financial institutions may be regarded as factories dealing generally in information transmittal, aggregation and disaggregation but more specifically in information evaluation. In some industries the network increasing returns to scale arguments are well known (see for example Arthur [1984, 1989]), but it is still an open question in the study of the banking industry (and other financial institutions), given the importance of both networks and location, as to whether increasing returns hold until there is only a surviving monopolist. It is my belief that even without legal constraints banking tends to an oligopolistic, not a monopolistic structure because of the blend of geographical space, network connections and expertise.

5. The Dynamics of Credit Assessment

A credit constrained closed economy can be viewed via an essentially static analysis with an extra set of credit constraint parameters on each individual and institution. The meaning and genesis of these parameters provide the link to dynamics and to the conventional analysis. They also tie into the full five C's version of the original three C's of credit assessment. They are Character, Competence, Capital, Collateral and Context. The last two cover guarantees from others and the relevance of macroeconomic overall assessment of the economy.

In a large economy much borrowing is quasi-anonymous in the sense that it is essentially on a mass basis to consumers, homeowners, small firms, car buyers all of whom, from the point of view of the lenders are a large anonymous set of risk classes. The individual is considered basically as a member of a risk class not as “Mr Jones”. Because loans involve the linking of at least two time periods they, of necessity, call for a paper trail (or its computerized equivalent). The members of the mass of small borrowers all have a relatively small “know who network”. In general few of them are known to more than a few thousand individuals most of whom do not know them in the context of an economic net.

6. Credit Constrained Exchange and Production Economies

A way of estimating the potential for monetization of credit in the economy is by comparative statics which takes as given the communication and goods and services nets and several different scenarios for the overall state of the economy. These provide the justification for placing the cash flow constraints on a standard equilibrium model of a multi-period economy. The cash flow constraints, in turn are eased by the granting of credit and credit depends on collateral and valuation. Valuation depends on specific detail considered in the context of the overall state of the economy.

6.1. Network Simulation or Analysis

Given a fixed institutional and macroeconomic context, a modification of the multistage general equilibrium analysis is sufficient to describe the credit conditions in an economy for a few years. The modification requires period-by-period cash flow constraints which are imposed in varying degrees on each individual according to the assessment of that individual’s credit-worthiness. If we regard the credit-worthiness measure of each individual as a parameter given as a datum of the model then there is a natural upper and lower bound to the credit structure of the economy. The upper bound is the standard Arrow–Debreu economy with only one final budget constraint. The lower bound is the no credit situation where each individual has to balance the books each period.⁸ A measure of the difference between the outcomes provides a valuation of trust or credit.

At a more basic level (and hence the title of this article) we may wish to ask where do the credit-worthiness parameters come from? They are derived from the information and knowledge network of the economy.

When the modeling of process is attempted the rules of the game must be given and these rules implicitly describe institutional structure. The contrast between the Cartalists and Mengerians referred to by Goodhart [1998] is not an “either/or” choice. Depending upon the starting point in history selected there is an intermix of the currently formal rules reflected in the laws (especially the enforcement of contract) and the body of custom and

⁸At its simplest each individual i might have a credit-worthiness parameter η_i where $0 \leq \eta_i \leq 1$, but in a more complex network world the parameter might be η_{ij} , i.e., i ’s credit rating with j .

practice which is always at work modifying the laws.

6.2. Network Assumptions

This section is devoted to considering the nature of the network and information structure required for the simulation of a network model to study the monetization of credit. This level of description is somewhat different from that of the general equilibrium model and from most macroeconomic models. The primitive elements are: 1. Natural persons; 2. Legal persons and 3. Government. From the point of view of economic activity we need to consider several networks. They are subsets of the “**know who network**”.

The “**know who network**”

Each agent of the three agent types may be considered as a node in a network. An arc connecting any two points indicates that A knows B if the arc is directed from A to B , say in the form $A \rightarrow B$. If B also knows A then the arc is described by $A \leftrightarrow B$.

Knowledge of others, acquaintanceship and friendship are all multidimensional phenomena, but from the viewpoint of finance and credit extension the 5 C’s provide a good basis and the credit evaluation programs are devoted to reducing the many dimensions to one, or at least, a few. Furthermore the laws of contract provide incentives for disclosure and compliance.

In particular in the relationship between A and B , intensity and duration of interaction may be of importance. Thus the concept of old friend or acquaintance implies some length of time of interaction, but a more intense relationship with the former than the latter. A ’s knowledge of B who is a senator or film star may be purely one way. A may have read a biography of B and have a fairly good character assessment of B , but B may not even know of the existence of A .

A specialization of the “know who network is to limit the net to economic concerns.

Properties of a credit system

In God we trust, all others pay cash
Old American Saying

In the development of mass market economics and finance more and more the trend is to make everyday personal consumption decisions anonymous from the point of view of the supplier. The local banker, retailer, restaurant or tailor are replaced by chains with branches or franchises. Only a small part of the “higher end” of the market merits explicitly personal service. In contrast with individual consumer behavior in an anonymous or impersonal market, large financial deals or corporate investments are made by fiduciaries often meeting face-to-face and hand-tailoring rather than mass producing the transaction. The fact that a large transaction is usually made by fiduciaries in the context of legal and accounting requirements increases the content of self-conscious optimizing behavior.

Underlying the credit granting mechanisms in a society are several basic properties:

Economy

1. **Symmetry:** This is a normative property which requires that all individuals who fit the same profile under a credit assessment system are treated identically in both credit arrangements and in the law.
2. **Optimality:** A credit arrangement must be perceived as benefitting all parties.

Information Costs And Evaluation

1. **Reputation:** This includes two of the classical 5-C's, Character and Competence, both are a function of the length of history on and "track record" of the individual.
2. **Loan length:** a. The longer the loan, the less certain the repayment; b. the longer the loan the more difficult the evaluation (*ceteris paribus*).
3. **Expertise:** Primarily because economists do not have a satisfactory theory of expertise there is a tendency to leave it out of consideration in economic theorizing. But much of finance is not merely an exercise in nonsymmetric information, but in perception. As such the role of the financier is not merely to have a finer perception or a refinement of the information sets of the layman, but to understand the dimensions and quality of risk in ways not perceived by others.
4. **Credit rating and due diligence:** Mass markets for small amounts of credit for consumption call for automated evaluation scoring for classes of essentially anonymous borrowers, this covers the majority of consumers. Credit markets for production tend to be less and less anonymous as the loan size and size of the institution increase.
5. **Context:** This is one of the 5 C's and in the actualities of credit granting summarizes the influence of the socio-political macroeconomic aspects of the situation when the loan is being made.⁹

Collateral and Contracts

1. **Information and collateral:** The larger the validated collateral, the less the need for knowledge of Character and Competence.
2. **Paper, goods and liquidity:** Collateral usually represents one's own or one's guarantor's capital in paper form. Individuals who mortgage their houses, in general, live in them, but those who borrow from pawnbrokers surrender the physical asset. If the mortgage is repaid the use of the house has not been interrupted, but its use as collateral has provided the means of obtaining the needed liquidity.¹⁰

⁹The understanding of the relevance of context is critical to all applications. A study of proverbs indicates that many of them occur in pairs which appear to contradict each other, yet depending on context each may be right. Thus we have: "Look before you leap" and "He who hesitates is lost".

¹⁰An interesting open question concerns what are the limits of "paper on paper"? As economies become more complex more instruments are invented. The common stock overcame the indivisibility problems caused by joint ownership of large assets. Warrants are second level paper and calls on warrants are third level paper. In a world without transactions, information or computation costs there appears to be no logical limit, but in actuality two to three levels appear to be sufficient.

3. **Contract, custom and enforcement:** The structure of the economy is in constant evolution, but in any small interval of time the rules of the game are more or less given.

Network Considerations

1. **Credit and non-face to face nets:** The ability to make mass consumer loans with little or no security and no face-to-face assessment requires that the issuer or sponsor have a visibility to large numbers as well as a favorable reputation. The minimum size for such an institution is undoubtedly dependant on many institutional parameters, but it appears that at the minimum the net of recognition is many thousands.
2. **Credit and face-to-face nets:** The number of entities required for the issue of information-intense lending is as low as two. Two large entities such as two international oil companies, if they have a continuing relationship can net their trades without bankers. In essence they accept each other's credits as bank money substitutes.
3. **Integration and merger as money substitution:** The large institution provides its own internal net, trust and enforcement structure. The corporation is able to net its internal credit arrangements with some flexibility as to when it has to balance the books.

6.3. The Credit Potential of the System

In the Appendix a simple example of two period trade is calculated to illustrate how, at the level of a simple general equilibrium model the information, evaluation and communication system requirements are considerable. The information and evaluation differences between this and the same markets using cash is noted. The fact that we use a credit system given the costs of evaluation may be regarded as a measure of the value of credit.

“Moneyiness” is a slippery concept to measure as is seen by the construction in the United States of $M1$, $M2$ and $M3$. Given these crude aggregates, when we compare them against the GDP we find a somewhat variable velocity. In the last twenty years the velocity associated with $M1$ has increased by around 14% and both the velocities associated with $M2$ and $M3$ have varied by over 10%. The variability is in part associated with the aggregates represented both in GDP and in the definition of the monetary aggregates. All forms of credit used as a general or local liquid means of payment need to be included in velocity calculations. But many forms of credit which might substitute for government or bank money are in control of subgroups or special nets in the economy. When circumstances change they may have a “know who network” slack of possibly as high as 20%. It is suggested that a way to estimate the variation in the creation of credit and in velocity would be to examine the strategic opportunities among six sets of agents: individuals, nonfinancial businesses, financial institutions, local government, federal government and the foreign sector. One may consider the 36 cells of interaction, for example among individuals there are the opportunities for slow payment and barter; among firms netting and slowing of accounts receivable; between the federal government and individual economic units there is

the whole battery of government policy on the interest rate, taxation, subsidy and spending, each of which in part influences velocity.

Table 2

| | GDP/M1 | GDP/M2 | GDP/M3 |
|----|---------------|---------------|---------------|
| 80 | 6.82 | 1.74 | 1.39 |
| 85 | 6.75 | 1.67 | 1.30 |
| 90 | 6.96 | 1.75 | 1.38 |
| 95 | 6.45 | 1.99 | 1.57 |
| 98 | 7.79 | 1.93 | 1.41 |

The government, even in a repressive dictatorship has never been a control monolith. The more a subgroup trusts its members and the more autarkic its needs are, the more it is in a position to substitute its means of payment and hence change the velocity measures.

6.4. Credit, Money and Everyone a Banker?

A somewhat esoteric, but nevertheless serious set of questions in economic theory is: Do we need a central bank? Could we run an economy with private banks or even individuals issuing their own money? (See Black [1970], for example.) Are government bankruptcy laws needed, or can the free market take care of default? The practical financier or director of a central bank might regard the questions as frivolous; but at the same time they fall in the same category as the Modigliani–Miller claim that under certain highly counterfactual conditions that corporate financial structure will not matter.

The careful mathematical analysis of Arrow and Debreu; the less careful but more institutional commentary of Modigliani and Miller and the utopian writings of Thomas Moore all share the implicit abstraction of a world with perfect trust and costless information. They provide an unwitting basis for a wishful thinking ideology concerning the virtues of an idealized competition that has never existed and will never exist in a world where information, knowledge, cognition and perception are not costless.

When a phenomenon is said to work in theory, but not in practice, what is implied is that the theory is not sufficient to cope with the reality. Both Arrow and Debreu and Modigliani and Miller’s results serve as the upper benchmarks for the ideal welfare world with perfect trust. It is also easy to mathematize the other extreme for a lower benchmark with no trust and no credit whatsoever. The complex world of money and credit, replete with a needed complex body of law and lawyers to adjudicate incomplete contracts, lies between the two.

In the example in the Appendix a credit assessment of each individual is given as a parameter of the game. But this one number M is made up of three numbers with immediate credit evaluation interpretation. $M = \eta p^* a^*$ where a^* is the estimate of *capital and collateral* held by an individual, p^* is the *context* of expected price, and η , the “haircut” can be considered to reflect the assessment of *character and competence*. In the one play game

an equilibrium dependent on the parameters will exist. But the credit evaluators might wish to adjust their evaluations in the light of the new market information.. Given the high dimensionality of the estimates¹¹ the demonstration that this will converge to a consistent rational expectations equilibrium is doubtful.

7. Concluding Remarks

In Moore's *Utopia* along with the perfect Arrow–Debreu world there will be no government or outside money as perfect trust, common knowledge and information prevails. Even there a numeraire might be needed if prices are utilized.. In this perfect world each individual issues his or her own credit or inside money. The world is so perfect that the accounting for debts outstanding for several decades among billions of individuals are recorded and balanced without costs or problems. All are their own bankers. All credit is monetized as the clearinghouse has a perfect dossier on all for all time.

In the world that we live in both inside and outside money exist, taking advantage of different information net structures, different levels of trust and due diligence and different levels of levels of enforcement against default.

Even if we were to accept the idealization that all individuals and institutions could issue their own paper, in a world where a government exists and by any reasonable economic measure is hundreds of thousands to millions of times larger and more well known than the individual,¹² if all agents are in a position to issue their own currency the government will issue its currency and due to its network recognition that form of credit will become the dominant money. The acceptance of any individual's or institution's IOU notes as generalized purchasing power will be a matter of network acceptance and this is more or less how the monetary and credit system works. IOU notes which have a large enough acceptance become a money. Any one can issue IOU notes, but they only become a money when they are broadly accepted. Apart from the government having the largest recognition network, its ability to tax and to issue more IOU notes secured by its full faith and credit also helps. But even then it is not necessarily enough. Both money and credit are manifestations of trust. A broad network recognition is necessary but not sufficient to support a money. Universal trust requires universal recognition, but universal recognition does not imply universal trust.

¹¹For n individuals there are $3n$ parameters without the added difficulties caused by the presence of exogenous uncertainty and production.

¹²For the United States the government is roughly 55,000,000 times wealthier and at the least 300,000,000/5,000 or 60,000 times more well known.

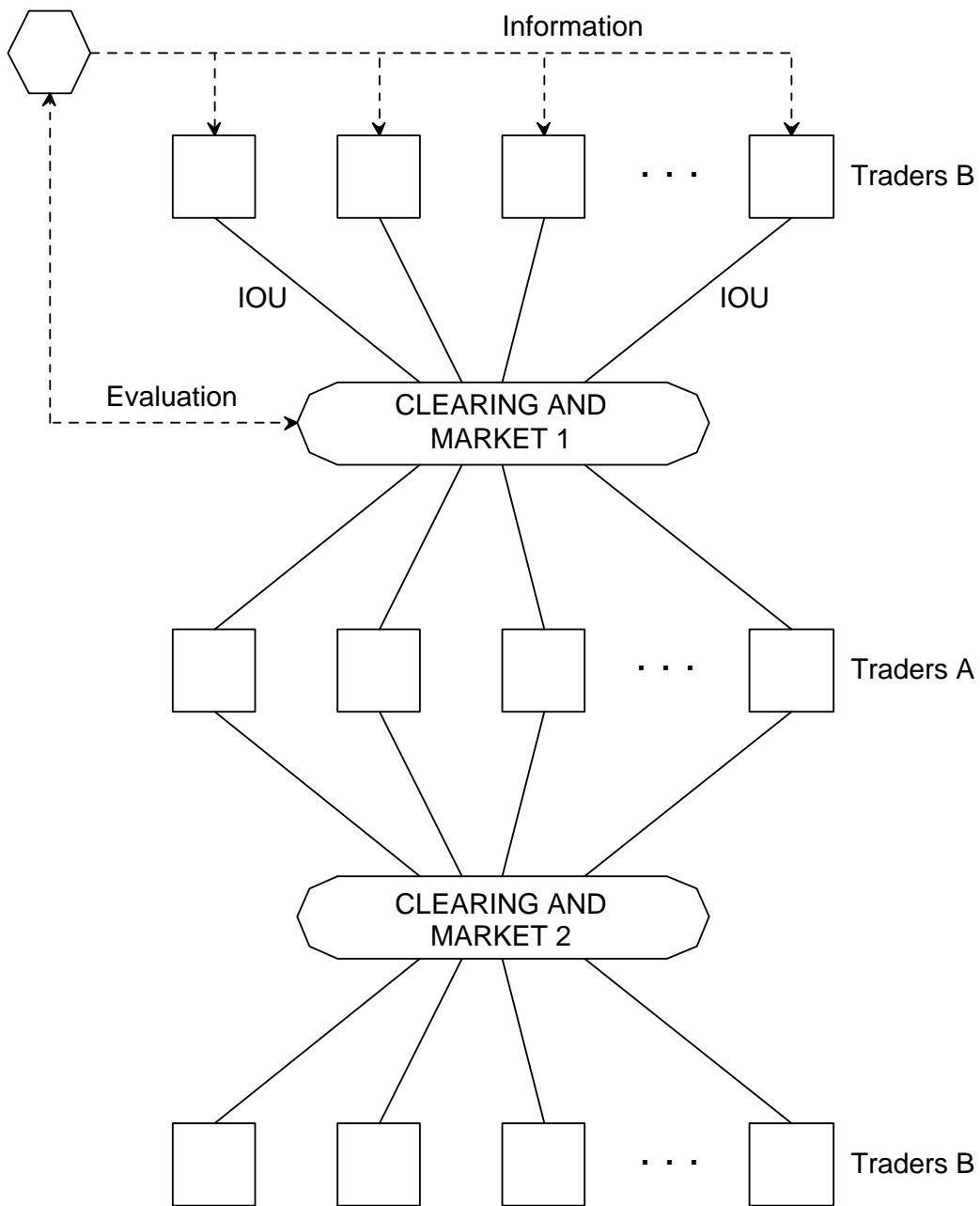
Appendix

There are three lengths of loan which merit formal mathematical modeling. They are: 1. the transactions or clearinghouse loan; 2. the short term loan and 3. the long term loan. They can be considered as a 0, 1 or 2 period loan. When A and B immediately exchange value for value utilizing some form of clearing arrangement there may be a brief interlude when one or both have given up some form of value and have not yet received the payment which is “in the mail”, the float or the clearinghouse. There are deep legal and technical clearinghouse problems in covering the few minutes or hours where one or more positions are not covered but in general clearing risks are not great (see Shubik and Slighton [1997], Goldman Sachs [1996], BIS [1996], Summers [1994]). However we confine our remarks to short term borrowing represented by two periods with a one period loan between them. New phenomena emerge in long term borrowing represented by a three period economy with the possibility for a two period loan. An important credit distinction among 0, 1 and 2 periods is (to a good approximation) the occurrence of 0, 1 and more than 1 unforeseen exogenous or endogenous events such as accidental or intentional default. With two periods the opportunity to create a second level of paper appears.

Two period trade

What does and what should the trading and credit network look like? For simplicity we consider a symmetric model. In doing so we lose the considerable network distinctions between small and large firms. Furthermore the intrinsic power and information asymmetry between consumer and retailer or consumer and banker is not illustrated explicitly, but is manifested in the network information conditions assumed. In fact in a large modern economy the relationship between buyer and seller is often nonsymmetric. Rather than claim realism in the sense of a close representation of an actual retail market our empirical test is to set it up as a playable experimental game. With this caveat the model suffices to illustrate the network, information and evaluation aspects of trade and credit. Figure 2 shows a many person modification of the Edgeworth bargain that is straightforward to formalize and analyze. A closer abstraction of retail trade and credit requires far more differentiation of actors. In a reasonable retail model the agents to be considered explicitly are the customers, the retail establishments, the banks, clearing arrangements and credit evaluation agencies together with the central bank and the employers of the customers modeled implicitly if the full circular flow of resources is to be illustrated.

In Figure 2 the two sides are both modeled as traders. The B 's buy from the A 's in period 1 and sell to the A 's in period 2. This is a far cry from the complexity of a retail market with consumer-customers and retailers often far larger and more connected than the individual buyer. However the structure in Figure 2 “stacks the cards” in favor of considering everyone being able to issue their own credit. Even so in any attempt to play a game with more than, say 10 agents per side the game designer is going to need to consider clearing arrangements. Complexity and communication are kept low by the introduction of two “black boxes”, the credit evaluation agency which provides the credit evaluations and



the market mechanism (see Shubik [1999], Chs. 5 and 6) which provides price generation, trades and clearing.

We provide a simple example of the type of model discussed in Section 6.3. where we consider a typical trader of Type *A* and of Type *B*.

There are two periods and one perishable commodity each period and spot markets only. Traders of Type *A* are endowed with $2a$ units of the first period good and nothing in the second period Traders of Type *B* have nothing in the first period and $2a$ units of the second period good. Symbolically the initial endowments are for Trader *A* $(2a,0)$ and for Trader *B* $(0,2a)$.

All of the traders have the same utility function which is of the form:

$$u(x_1, y_2) = 2\sqrt{x_1} + 2\sqrt{y_2}$$

If we attempt to utilize this model as a playable game several more features must be specified. They are the level of common knowledge between the traders, the existence of a numeraire and the rules concerning default. We assume common knowledge and the existence of a numeraire. Call it “the Ideal”. It need have no physical existence, but it immediately takes on utilitarian value if the default penalty is unpleasant and the intensity of the default penalty is linked to the size of the default measured in units of Ideal. The unit of societal punishment is some form of disutility measure whose scale we might call the “Bentham”. Thus the dimensions of the bankruptcy penalty are “Benthams/Ideal” (or BI^{-1}). We may modify the utility function to reflect the default condition to be:

$$u(x_i, y_i) = 2\sqrt{x_i} + 2\sqrt{y_i} + \mu[\text{Default size}]$$

where μ is a parameter which can be interpreted as the marginal disutility of default.

We first comment on a two person economy. It is difficult to conceive of a two person society. But the closest to the two person situation we might get is two socialized individuals, say undergraduates in a bargaining experiment. The referee can control whether they have known each other previously and whether or not they bargain face-to-face. The Edgeworth [1881, 1932] two-person analysis implies face-to-face bargaining with an exchange of two current goods determined without a price signal ahead of time. Here we could conceive of an experiment using two freshmen with the first move made by Trader *A* at the start of the first semester and with the second move made by Trader *B* at the start of the next year when they come back as sophomores (if they come back and the experimenter is still there and the notes from the first part of the experiment can be found). Credit requires some form of contract between the two traders.

In Shubik [1999] trade utilizing either fiat money or gold has been discussed. Implicit in the discussion was the assumption that all payments were in cash and all individuals recognized and accepted gold or fiat. When neither gold nor fiat exist trade must depend on inside money. We may introduce a parameter to reflect the overall degree of trust between Trader *i* and trader *j*, or more realistically if there are many traders of each type and they are trading through a more or less anonymous market we may assume that in any random pair, traders do not know each other, hence the trust parameter is that of the bank or in the game, the referee. This parameter, can be considered as the “credit assessment” parameter. As argued above, it is determined for each individual by information and network

considerations.¹³ We select a parameter η where $0 \leq \eta \leq 1$.

Actual trade is embedded in time. There is usually a history of the market. For instance the last market price is known. For purposes of credit evaluation we need to be able to estimate the individual's assets and their expected value. If a^* is the estimate of the quantity of assets held by an individual and p^* the expected price, the amount $\eta p^* a^*$ can be considered to be the size of the credit line as estimated by the banker. Here the η can be regarded as the "haircut" or the discount on the valuation of the asset given for the borrower's protection. If we wish to consider a playable game where each trader is his own banker then we must assume that in a mass market at least the market clearing agency is aware of the reputation and creditworthiness of each individual i in the suggested limit of the amount $\eta_i p^* a_i^*$ on the acceptability of the individual's paper.

We can see immediately the upper and lower bounds of full credit and no credit in this exchange. Full credit can be simply portrayed by the standard general equilibrium solution. Due to the simplicity of the example we can solve by inspection. The utility to each is initially $2/\sqrt{(2a)}$ and the final utility for each is $4\sqrt{a}$.

When $\eta = 0$ no trade will take place and the final utility is the same as the initial autarkic solution. In this simple instance the utility functions being all the same we have a simple measure for the value of trust going from the no trust instance to the full trust of general equilibrium.

The credit constrained equilibrium solution

Model 1: It is sufficient to consider the instance of trade without active default to illustrate the influence of the credit constraints. In order to do so we merely solve a credit constrained general equilibrium model. This amounts to solving the two expressions of the form:

$$u(x_1, y_1) = 2\sqrt{x_1} + 2\sqrt{y_1} + \lambda_1[2ap_1 - p_1x_1 - p_2y_1]$$

and

$$u(x_2, y_2) = 2\sqrt{x_2} + 2\sqrt{y_2} + \lambda_2[2ap_2 - p_1x_2 - p_2y_2] + \lambda_3[\eta p_1^* a^* - p_1x_2]$$

where the extra constraint in the second equation reflects the credit restriction. We obtain 9 equations of the form:

¹³Fifty years ago the determination might have involved a local banker for small loans, currently a credit evaluation firm may supply the banker with an evaluation.

$$\begin{aligned} \frac{1}{\sqrt{x_1}} &= \lambda_1 p_1; \quad \frac{1}{\sqrt{y_1}} = \lambda_1 p_2; \\ \frac{1}{\sqrt{x_2}} &= (\lambda_2 + \lambda_3) p_1; \quad \frac{1}{\sqrt{y_2}} = \lambda_2 p_2; \\ x_1 + x_2 &= 2a; \quad y_1 + y_2 = 2a; \\ 2ap_1 &= p_1 x_1 + p_2 y_1; \quad 2ap_2 = p_1 x_2 + p_2 y_2; \\ M &= \eta p^* a^* = p_2 y_2. \end{aligned}$$

Solving we obtain:

$$p_2 = \frac{2a - M}{M}$$

and

$$\lambda_1 = \frac{1}{\sqrt{2a - M}}; \quad \lambda_2 = \lambda_1 \frac{\sqrt{M}}{2ap - M}; \quad \lambda_3 = \frac{1}{\sqrt{M} - \lambda_2}$$

with

$$x_1 = 2a - M; \quad x_2 = M; \quad y_1 = \frac{M^2}{2a - M}; \quad y_2 = 2a - y_1.$$

We may check to see that when $M = a$ we obtain the competitive equilibrium solution with

$$x_1 = x_2 = y_1 = y_2 = a; \quad \lambda_1 = \lambda_2 = \frac{1}{\sqrt{a}}; \quad \lambda_3 = 0; \quad p_1 = p_2 = 1.$$

When $0 < M < a$ the credit constraints become binding. (When $M = 0$ there is no trade and λ_2 is not defined.)

Model 2. Two person trade with gold or fiat as money
Gold

We can modify model 1 by introducing an ideal gold. Such a gold would be the equivalent of a transferrable utility. Thus we can imagine a new playable game where each Trader has an initial endowment as follows. Type *A* has $(2a, 0, M_1)$ and Type *B* has $(0, 2a, M_2)$ where the utility function for each is

$$u(x_i, y_i) = 2\sqrt{x_i} + 2\sqrt{y_i} + m_i$$

where gold appears as a perfect money with linear utility.

The pattern of trade is essentially the same as in Figure 2 with the deletion of the credit assessment as the cash payment in gold makes it unnecessary.

Fiat

When fiat is used instead of gold. If the individuals trust the government to the extent that each believes that the other will accept the currency then the system with fiat (Kiyotaki and Wright [1989], Bak, Nørellykke and Shubik [1999]) requires no extra information beyond the knowledge that all will accept the fiat. The distinction between the ideal gold and the acceptable fiat can be illustrated considering two matrices. The first is an intrinsic valuation matrix and the second is an acceptance matrix. Any pair of matrices represents i 's estimate of j 's acceptance and valuation.

| | | | |
|--|--|--|--|
| $\begin{bmatrix} 1 & 1 & 1 & \dots & 1 & 1 \\ 1 & 1 & 1 & \dots & 1 & 1 \\ \vdots & & & \ddots & & \\ 1 & 1 & 1 & \dots & 1 & 1 \end{bmatrix}$ | $\begin{bmatrix} 1 & 1 & 1 & \dots & 1 & 1 \\ 1 & 1 & 1 & \dots & 1 & 1 \\ \vdots & & & \ddots & & \\ 1 & 1 & 1 & \dots & 1 & 1 \end{bmatrix}$ | $\begin{bmatrix} 1 & 1 & 1 & \dots & 1 & 1 \\ 1 & 1 & 1 & \dots & 1 & 1 \\ \vdots & & & \ddots & & \\ 1 & 1 & 1 & \dots & 1 & 1 \end{bmatrix}$ | $\begin{bmatrix} 0 & 0 & 0 & \dots & 0 & 0 \\ 0 & 0 & 0 & \dots & 0 & 0 \\ \vdots & & & \ddots & & \\ 0 & 0 & 0 & \dots & 0 & 0 \end{bmatrix}$ |
| Acceptance | Valuation | Acceptance | Valuation |
| Ideal Gold as Money | | Fiat Money | |

References

- Arthur, W.B. (1989), 'Competing technologies, increasing returns and lock-in by historical events', *Economic Journal*, 116–131.
- Arthur, W.B. (1994), *Increasing Returns and Path Dependence in the Economy*, Ann Arbor: University of Michigan Press.
- Bak, P., S. Nørrelykke and M. Shubik (1999), 'Dynamics of money in a market economy', *Physical Review E*, 60 (3), 2528–2532.
- Bank of International Settlement (BIS), 1996 on the security of electronic money.
- Black, F. (1970), 'Banking and interest rates in a world without money', *Journal of Bank Research*, 9, 20.
- Boissevan, J. (1974), *Friends of Friends: Networks, Manipulators and Coalitions*, London: Basil Blackwell.
- Dubey, P., A. Mas-Colell, and M. Shubik (1980), 'Efficiency properties of strategic market games: An axiomatic approach', *Journal of Economic Theory*, 22, 339–362.
- Edgeworth, F.Y. (1932), *Mathematical Psychics: An Essay on the Application of Mathematics to the Moral Sciences* (original, 1881). London: London School of Economics.
- Goodhart, C. (1998), 'The two concepts of Money: implications for the analysis of optimal currency areas', *European Journal of Political Economy*, 14, 407–432
- Goldman Sachs (1996), Symposium on Risk Reduction in Payments, Clearance and Settlement Systems, N.Y., N.Y.
- Granovetter, M.S. (1973), 'The strength of weak ties', *American Journal of Sociology*, 78, 1369-1380.
- Jevons, W.S. (1875), *Money and the Mechanism of Exchange*, London: MacMillan.
- Kiyotaki, N. and R. Wright (1989), 'On money as a medium of exchange', *Journal of Political Economy*, 97, 927–954.
- Milgram, S. (1967), 'The small world problem', *Psychology Today*, 1, 62-67.
- Rosenberg J. and A. Gleit (1994), 'Quantitative methods in credit management', *Operations Research*, 42 (4), 589.
- Shubik, M. and R L. Slighton (with the collaboration of G. J. Feeney) (1997), *The Defense Implications of the Recent and Future Changes in the World Monetary and Financial Systems*.
- Shubik, M. (1999), *The Theory of Money and Fiancial Institutions*, Cambridge MA: MIT Press.
- Summers, B. (ed) (19XX), *The Payment System*, Washington, DC: International Monetary Fund.
- Wechsberg, J. (1966), *The Merchant Bankers*, Boston, MA: Little, Brown.
- White, H.C. (2001), *Markets from Networks*, Princeton, NJ: Princeton University Press.