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TECHNOLOGICAL CHANGE IN THE FINANCIAL SYSTEM--
WHERE IS THE PAPERLESS SOCIETY?

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Technological Change in the Financial System— Where is the Paperless Society?

"In recent months there has been increasing interest in the rapidly developing concept of a cashless, checkless, society...[8, p. 3]

"The time is fast approaching when individuals—not to speak of banks—will find the conventional check becoming a high cost, obsolescent device for most transactions; then the electronic payments system will be not only a convenience, but also an economic necessity."[9, p. 18]

These are very timely statements. We seem to be moving at an accelerated pace toward an electronic-based payments system. Perhaps surprisingly, however, the statements quoted above were made in 1969 and 1971, over ten years ago.

During the late 1960's and early 1970's, many felt we were on the verge of becoming a paperless society. One group of analysts went so far as stating that:

"[t]hough speculations about developments in the future are sometimes unrealistic, it now appears certain that by 1980 very few American shoppers will be carrying bulky checkbooks in their purses or large amounts of cash in their wallets. The present proliferation of credit cards of all sizes, shapes, and colors will also be largely a thing of the past."[1, p. 10]

This group went on to predict a full-scale electronic payments system in operation by the beginning of the current decade.

These predictions notwithstanding, we generate more paper now than ever before. In 1967, an estimated 18.7 billion checks were written in the United States[6]. By 1979, the annual check volume had increased to an estimated 32 billion[3]. Credit cards have shown similar dramatic increases, with the volume of card transactions for Visa and Mastercard alone totalling nearly 1.5 billion in 1979 compared with 750 million in 1975[2]. We are far from a paperless society.

Electronic payments have, of course, also grown in volume. Virtually all transactions among commercial banks are now electronic. The Federal Reserve System processed 35 million such transactions in 1980 on its FedWire facilities and BankWire and CHIPS processed an additional 16.8 million transactions. These payments accounted for a dollar volume of \$110 trillion. Electronic payments through Automated Clearing Houses totalled 172 million in 1979[2]. At the retail level, electronic technology also appears to be spreading, but it by no means dominates. Even most electronic retail payment systems such as Point-of-Sale terminals and Automated Teller Machines use paper verification systems.

Given these observations, many close to the industry are asking what has happened. Where is the paperless society? Many still expect it to emerge. The major purpose of this paper is to examine that possibility by exploring the process by which payments system innovation occurs. The first section applies the economics of innovation to the growth of electronic banking; the second section uses the framework provided by that exercise to examine the significant factors that influence the spread of electronics in banking; and the final section presents a view of the likely evolution of the payments system. This paper does not attempt to measure relative efficiency of various payment systems. For purposes of discussion it accepts the premise that electronic innovation promises some benefit to participants in the payments process (in terms of reduced costs or improved performance).

I. Electronic Payments and the Economics of Innovation

Electronic payments prognostications are generally based on a common, but fairly loose, concept of a "product life cycle". An s-shaped product life cycle curve which is fairly well established in marketing literature divides product life into four stages--introduction, growth, maturity and decline. The typical exposition of such a curve is shown in Figure 1. The introduction stage is characterized as a learning period. A product is new on the market and well known to only a few market participants. As

knowledge of the product spreads, and refinements are made by producers, the product "catches on". This begins the growth stage. During the growth period, market penetration by the product increases rapidly until the market is saturated and the product is "mature". The mature product begins to "decline" when new substitute products have been introduced or the product has outlived its usefulness. Analysts that predict rapid growth of electronic payments today view electronic payments as reaching the second life cycle stage.^{1/} Analysts in the late 1960s thought that stage had been reached then.

This interpretation of payments system innovation is useful, only for a narrow range of innovations. The progress of payments system innovation in general can be more satisfactorily modeled by viewing electronic payments not as a product, but rather as a method by which a product—payments services—is produced. This approach is described below.

Payment Systems as Production Technology

We may view financial intermediation as an industry and financial intermediaries (or commercial banks) as profit-maximizing firms. Payments service—the transfer of funds on behalf of a paying party—is among the products "sold" by financial intermediaries.^{2/ 3/} The method by which payment is accomplished is the production technology of the financial intermediary. In an all-cash world, for example, the production technology would consist of the physical movement of currency between the payor and payee. Use of checks to order payment could be viewed as a refinement to the all-cash technology. Innovations to the payments mechanism are viewed as changes in

^{1/} See, for example [3].

^{2/} The fact that there may be no explicit charge for the payments service does not diminish its importance as a product. Where no explicit charge is made, it may be viewed as part of a bundle of products.

^{3/} Henceforth we shall use the terms "bank" and "financial intermediary" interchangeably.

available production technology. Thus, the rate of adoption of electronic payments innovations can be modeled from the viewpoint of the financial intermediary.

In general, we would expect a production technology innovation to be adopted by a firm at the point in time when the firm views the return to be gained from its adoption as exceeding the cost of switching to the new production technology from existing methods. More formally, an innovation will be adopted by a firm at that point in time when the discounted cash flow attributed to the innovation over time exceeds its adoption cost. If the cost structures of individual firms vary, the optimal time at which to adopt an innovation will vary across firms. In approaching its decision of whether or not to adopt a new technology, the firm will consider not only direct costs of installing the new system but also the indirect costs of incorporating the system into its operations. Further, in the real world, uncertainty will also affect the firm's decision process. For all of these reasons, even an innovation that significantly dominates existing technology will be adopted only gradually.^{4/}

Conveniently, this approach leads to a life-cycle curve similar to that in Figure 1, and this curve has been widely endorsed in the literature on innovation. However, the interpretation of the curve differs importantly from the marketing interpretation. The curve measures the rate of adoption of a technology by individual institutions that make the adoption decision on the basis of relative costs.

Applying this approach to the issue at hand, we may state that a bank will adopt a new payment technology (electronics) when it expects the future stream of profits attributable to that technology to outweigh its costs of implementation. An important point is that this statement applies to individual payment innovations. There is no single "payments mechanism" in place. The method by which payment is accomplished depends on the nature of the payment and on the identity of the payment participants (the payor

^{4/} See [5] for a good review and critique of literature on this process.

and payee). Banks offer a wide array of payment services for their customers. The nature of the payment itself tends to vary with the characteristics of the payor and payee. And the efficient choice of productive technology for a bank of course depends on the nature of the payments that the bank facilitates. Thus, choice of productive technology by an individual financial intermediary will depend, in part, on its customer base.

It will be useful conceptually to group domestic payments participants (payors and payees) into five groups—depository institutions, nondepository financial institutions, nonfinancial firms, individuals, and governmental units. Payment transactions occur among economic units within and across all five categories, and the specific technology through which a given payment is accomplished depends, in part, on the nature of the payment participants. The existing payment services available to payment participants can be described by a diagram such as that sketched in Figure 2. Each payment can be classified according to identity of payor and payee, size of transaction, and frequency of payment. Figure 2 demonstrates this classification for one class of payment—small recurring payments by individuals to firms.

For each class of payment, a number of alternative payment mechanisms exist. Some of these mechanisms involve a bank. The payor and payee jointly select the appropriate payment mechanism. When the payment participants elect a mechanism that involves a financial intermediary, the financial intermediary "sells" a payment service. For each payment service provided by a bank, there is a particular production technology available. A given electronic payment innovation may imply changes in the production technology used for one or more payment services.

This approach provides a clearer meaning for the innovation life cycle curve. The shape of that curve will depend on the nature of the particular innovation under consideration. The rate of adoption of point of sale technology, for example, is not necessarily similar to the rate of adoption of telephone bill paying technology. And,

while a continuous curve may be applicable to each of these individual innovations, it may not provide any insight into the process of complete automation of the payments system.

The Nature of Electronic Payment Innovations

Electronic payment innovations can be divided into two categories—customer directed and internal. Customer directed innovations are those which affect the manner in which the customer interacts with the financial intermediary. Point of sale terminals and automated teller machines are in this group. These innovations refine the process by which the customer instructs his bank to make payments. As such, they directly affect customer utility and customer demand for payment services.

The second type of innovation—internal innovations—refers to those which are part of the production process that is not directly visible to the customer. These innovations will affect the consumer only insofar as they affect the nature of the payment service. For example, certain types of innovations increase the speed with which a payment may potentially be completed. The customer would be affected by this characteristic only if that potential is exploited by the providing bank. Internal innovations generally are those which improve the efficiency of a bank's production process and which may, at the bank's discretion, increase (or decrease) the value of the service to the customer.

Internal payment system innovations can be further classified according to whether they are private or inter-bank. Private (pure internal) innovations can be instituted by the bank for its own operations—better computer equipment or better check sorters, for example. Inter-bank internal innovations, on the other hand, involve changes in the technology by which payments pass from one bank to another. These generally are innovations in clearing and settlement operations. Obviously, implementation of such an innovation requires its acceptance by more than one bank.

These three classes of electronic payment innovations—customer directed, pure internal and internal inter-bank—all have the potential to alter not only the nature of the payment technology, but also the nature of the payments themselves. For example, our common check payment system is "debit-based." Goods and services are provided in exchange for the check instrument. The check is credited by a bank to the payee then sent to the payor's bank where it is debited from the payor's account. During the period of time between receipt of the check and debiting of the payor's account, the payee bears a risk—the possibility that the payor's bank will not ultimately remit funds in exchange for the check. Point of sale terminals may be used to initiate "credit-based" payments. Funds may be debited from the payor's account simultaneously with the provision of goods and services. This substantially alters the nature of the payment received by the payee by eliminating the risk of nonpayment.

Changes in the nature of payments themselves may be either a benefit or a cost of a technological innovation. In the above example, the payee would view the change favorably; the payor, on the other hand may view the change unfavorably since it implies a faster payout by his bank.

The Innovation Adoption Decision

The general rule for a bank facing a payment system innovation is as follows: "Adopt the innovation if the discounted value of future income attributable to the innovation will exceed the cost of adoption."

This rule may be implemented straightforwardly for the case of a pure internal innovation that will not alter the nature of the payment or the payment service. An example of such an innovation is more efficient check processing equipment. Such equipment might enable a bank to process paper checks less expensively but would not affect the customer in any way. An electronic example might be a more efficient computer memory. Such an innovation would reduce the cost of processing payments electronically, but would not affect the customer. This type of innovation is directly anal-

ogous to innovation in a manufacturing process. As such, it has been the subject of a substantial volume of economic analysis.^{5/} Unfortunately it is also the least interesting type of payment system innovation.

Customer directed innovations and pure internal innovations that alter the nature of the payment itself are complicated by the fact that their implementation affects not only bank costs, but also demand for affected payment services. Changes in demand alter future bank income and, thus, enter the bank's adoption decision.

Internal inter-bank innovations require inter-bank cooperation. Such innovations cannot, by definition, be instituted by a single institution operating independently. This is important because the cooperation required can involve important costs. The economic literature on innovation emphasizes the significance of the ability to protect the use of an innovation from competitors. In the case of inter-bank innovations, use not only cannot be kept private, but in fact all participants stand to gain equally. In this circumstance individual actions break down and some "collusive" action may be warranted.

The following section discusses the major factors that influence payments innovation decisions and addresses the forces that have prevented the widespread electronic usage that was envisioned in the 1960s.

II. Factors Affecting Electronic Payment Innovations

The framework described in the previous section views electronic payment innovations as changes in payment production technology. The likeliness that a particular innovation will be adopted by an individual bank is expected to vary directly with the perceived production cost savings and/or service demand increase resulting from the innovation and inversely with the level of the fixed cost of innovation. Evaluation of the magnitude of production cost savings potential of various innovations is beyond the scope

^{5/}See, for example, Gold, op.cit.

of this paper. Most analysts appear to agree that the potential savings over paper-based systems are substantial. We shall accept this premise for the sake of discussion and explore the question of whether eventual dominance of our payments system by electronics is therefore inevitable. In this section we will examine demand factors and implementation costs as determinants of innovation adoption rates.

Demand Factors

Adoption rates for customer directed innovations and internal innovations that alter the characteristics of the payment that is provided can be either accelerated or retarded by demand factors. Demand effects for customer directed innovations are of three general types—customer start-up costs, customer marginal costs and privacy considerations.

The nature of customer start-up costs varies according to type of customer. For commercial customers, these are operating costs--the costs of adopting new internal procedures to facilitate interaction with the new payments technology. For individuals, these are often termed "psychic" costs—distrust of electronics, for example—but there also are identifiable costs in the form of time required to implement new personal finance procedures. Customer marginal costs represent the difference in cost per transaction borne by the customer using the new technology rather than the existing technology. Obviously, this can be either positive or negative. Privacy considerations are listed separately as they are external to the payments process. They affect utility (of individuals) or profits (of commercial customers) in a manner unrelated to the quality of payment services received. At the individual level, these considerations have been expressed as a concern that electronic payment technology may involve a centralization of personal records that would be detrimental to personal well-being.

For innovations that alter payment characteristics, two particular characteristics are relevant—risk allocation and payment speed. We would generally expect any payment system participant (payor or payee) to prefer the technology that minimizes its

own risk share. Likewise, payors would prefer a slower payment process while payees would prefer a faster process. The risk altering example discussed in Section I demonstrates that changes in payment technology may actually change the aggregate risk inherent in the payment process. Thus, some risk altering innovations may be endorsed by all participants. For the case of payment speed, we tend to have a zero-sum game, and we would expect that the party standing to lose from adoption of the innovation would refuse the innovation unless compensated in some way.

All of these demand factors are relevant to the individual bank. Each customer, faced with a new technology adopted by its bank will make the decision of whether to use that bank and the technology or whether to purchase payment services from a bank still using established technology. Accordingly, aggregate demand for the bank's payment services will be affected by the technological innovation.

Implementation Costs

For customer-directed and pure internal innovations, implementation costs may be calculated straightforwardly. As mentioned previously, these include not only the physical costs of purchasing and installing new equipment but also the less direct costs of overcoming organizational inertia to switch to new techniques.

For inter-bank internal innovations the need for coordination is a substantial implementation cost. Banking is a competitive and highly fragmented industry. Voluntary cooperation on major innovative proposals can therefore be an expensive undertaking. In a rapidly moving technology a special cost is present in the form of the possibility that technology may be outmoded by the time its coordinated adoption can be engineered.^{6/}

^{6/}The relevance of this concern is pointed up by the drama currently being played out in the credit card industry. Industry members (card manufacturers, retailers and financial institutions) reached agreement in the early 1970s on a standardized magnetic strip technology. This technology was to be fully implemented by next year. Last year, a French corporation introduced a new micro-processor chip-embedded card that has threatened to replace the not-yet-standard magnetic strip.

III. The Future of Electronic Payment Innovations

The discussion of the previous two sections assesses electronic payment innovations as a bank productive decision. It is clear that the innovation adoption decision hinges on more than a simple productive efficiency evaluation. To a large extent, the factors outlined in the previous section account for the absence of the paperless society. And those same factors provide important clues to understanding whether a paperless society will be forthcoming.

Why We Still Have Paper

Customer start-up costs, privacy considerations and resistance to increased payment speed appear generally to have offset efficiency gains, customer marginal cost reductions and risk reductions promised by customer-directed innovations for all but the largest customers in the 1970s. This balance has been further tipped in favor of traditional paper-based systems by various Federal Reserve System policies.

At the retail level, consumers resisted computer technology, partially due to psychic start-up costs and partly due to an aversion to a centralized data base that many anticipated could evolve from electronic payment set-ups. This latter concern appears to have been founded in some basis of fact. It was not uncommon for payment systems analysts of the period to cite aids to tax collection and reduced opportunity for fraud and money crime as advantages of electronic payments systems.^{7/}

Consumers also saw little advantage to innovations such as point of sale terminals that increased the speed of final payment. The typical retail check payment is not debited from a consumer's account until two or three days from the date payment is made. The value of "float" enjoyed during payment clearing has tended to offset the reduced marginal cost of consumer transactions.

^{7/} [4], for example, sees electronics as creating an "economically naked" society. This is viewed as a benefit to be weighed against the cost of displacement of clerical workers.

At the commercial level, similarly, start-up costs and loss of float were generally significant enough to outweigh marginal cost savings. Most of the interest in automated clearinghouse transactions has come from government agencies. Such transactions as direct deposit of social security checks, for example, accounted for over 80 percent of total ACH volume in 1979 [2].

For large transactions, however, electronic innovation has been adopted by commercial customers. For these transactions payees have refused to bear the cost of float and have been instrumental in the spread of innovations such as customer-directed wire transfers.

Customer directed innovations generally were slowed by the role of the Federal Reserve System in the paper-based system. In its clearinghouse role, the Fed provided check processing at no charge to member banks, and in the late 1960's, when it became clear that check processing capabilities would be insufficient within a decade, the Fed expanded its processing capability by establishing regional check processing centers that were available even to nonmember banks. This provision of free checking was passed on to consumers as a result of the prohibition of interest on demand deposits. This prohibition encouraged implicit payment for deposit balances, and free checking has been an important part of that implicit payment. Finally, the value of Federal Reserve float has further tended to reduce the motivation for payors to speed the transactions process.

At the same time, Federal Reserve presence has tended to spur development of internal inter-bank innovations. With regard to such innovations, the Federal Reserve has been able to serve as a coordinator and establish uniform standards to help bring payments participants together. Some of these innovations, such as MICR encoding of checks, have further entrenched paper-based systems; but some, such as FedWire and regional clearinghouse arrangements, have spurred electronic payment technology. The major stumbling block for internal inter-bank innovations remains the level of coordination costs and start-up costs. Particularly significant is the uncertainty surrounding legal

aspects of new payment modes. Such issues as reversibility of transactions and risk allocation are well defined by the Uniform Commercial Code for familiar, paper-based systems. Many of these issues are unresolved for electronic systems.

Why Paper is Not Going Away

Many factors make it likely that the rate of adoption of electronic technology will increase in the 1980s. General Economic Conditions are tipping the scale toward electronics. Rising costs of energy and labor are increasing the attractiveness of electronics versus paper. At the same time, narrowing interest spreads are increasing the need for banks to have the capability to rapidly channel funds to profitable areas. Growing internationalization and increased geographic scope of domestic operations are reducing the feasibility of paper transmittal. Along with this, the increased uncertainty of the economic environment is increasing the attractiveness of immediate clearing. Customers are likely to demand a shift to more credit-based payments.

Technological Developments are reducing the cost of many electronic elements. An important development has been the substantial progress in miniaturization that has been made in the past decade. Miniaturization of computer hardware has progressed to the point where the volume of transactions implied by a checkless, cashless, society is now actually feasible. Miniaturization also has increased the attractiveness of the system to individuals. The proliferation of home computer devices promises to greatly aid the progress of electronic banking.

A recent development, "memory" cards has important implications. The computer chip has made feasible production of credit card sized memory "computers" that could store data for individual consumers. This may eliminate the need for the feared central file.

The Regulatory Environment is also changing in ways that may be favorable to electronic technology. The Monetary Control Act requirement that the Federal Reserve System price all services will end, or at least reduce, the paper subsidy. This

will force those who prefer a paper system to bear its costs and should spur shifts to electronics. Pricing of float, which is slated for 1982, will eliminate some incentives that favor delayed clearing. Some market participants have even argued that the Federal Reserve's pricing policies are underpricing electronics compared with paper. The pricing system is based on costs assuming a system working at full capacity. With electronics in its infancy, this approach understates the true per item cost of electronic processing in the short-term.

The advent of interest-bearing transactions accounts has also reduced the value of our delayed-clearing debit-based system by reducing the cost of holding balances. And the blurring distinction between banks and other financial institutions has created new instruments that may best be administered electronically.

In spite of all of these positive factors, however, a complete abandonment of paper is not likely in the foreseeable future. Visionaries of the electronic persuasion tend to argue that an all-electronic world would work better than our current one and therefore will emerge. However, they do not address the mechanics by which the system will evolve.

The framework presented in this paper emphasizes the heterogeneity of payments and the range of efficient payment process. It points out the complexity of the decision-making process that results in a financial intermediary adopting a particular innovation. Recognizing the array of innovations under consideration and the number of independent financial intermediaries in our payments system, we must conclude that a paperless society will emerge only slowly, if at all.

It is quite likely that most wholesale transactions will be conducted electronically in the near future. It is also likely that a substantial portion of frequently recurring retail transactions will be electronic. However, it is not likely that we will see the elimination of currency and paper-based transactions short of a government decree to that effect.

Figure 1
Product Life Cycle

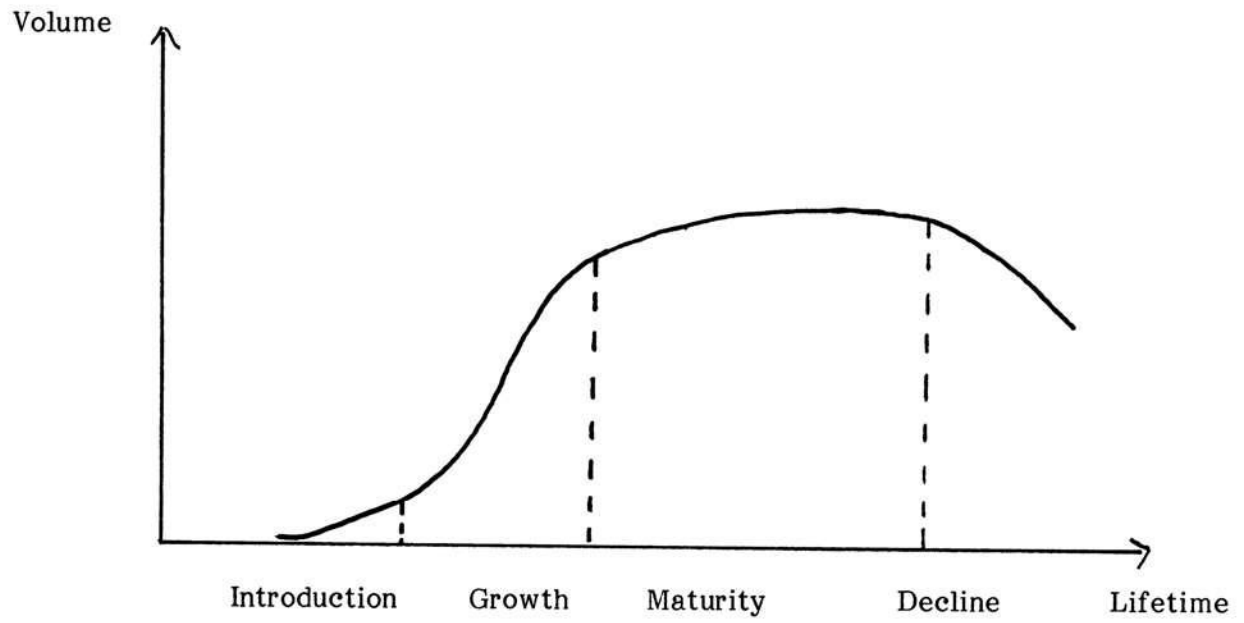
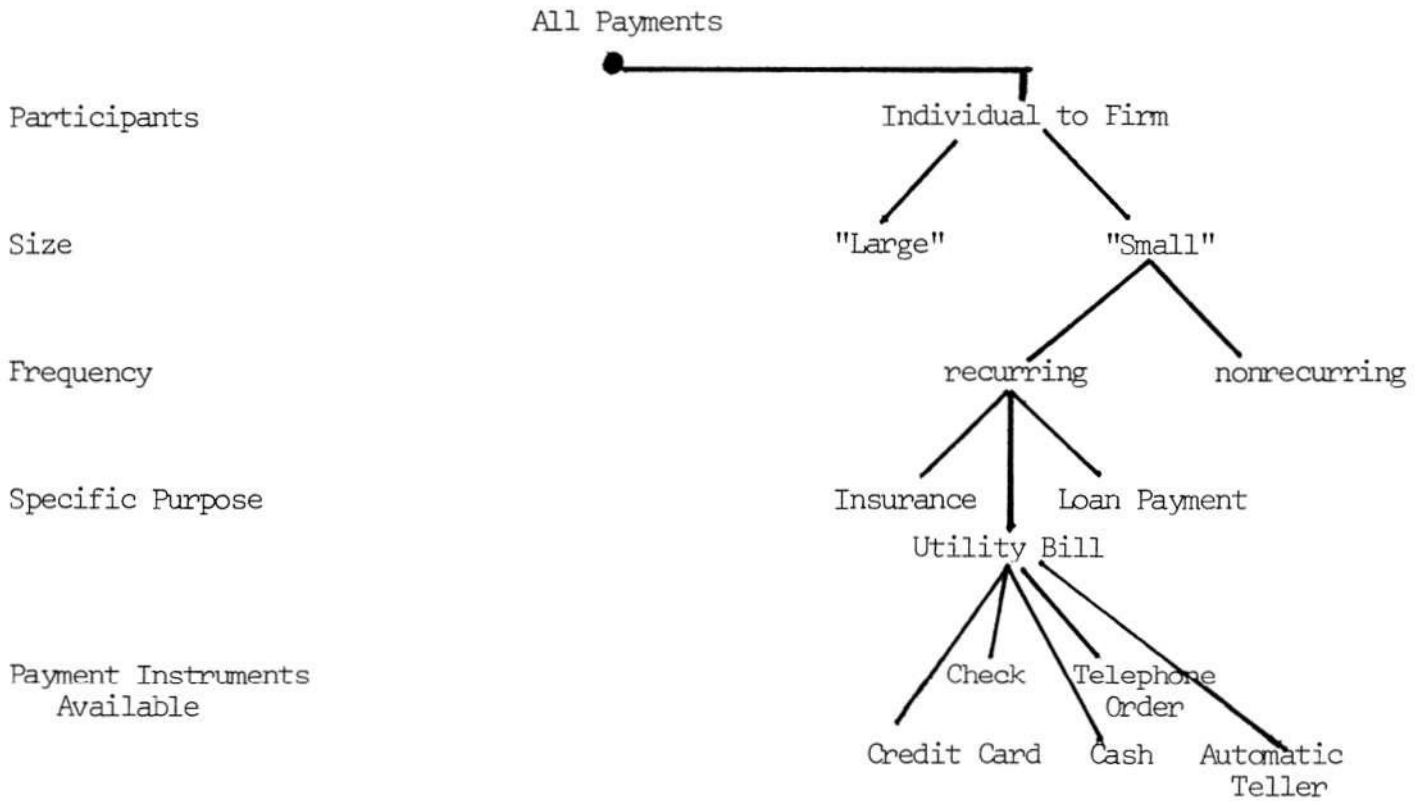


Figure 2

Technique For Classification of Transactions



Note: This is an adaptation of an approach suggested by T.R. Marshall and R.I. Soler in "An Approach to Forecasting EFTS Volumes" Federal Reserve Bank of Atlanta, February 1975.

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