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Cash for Banking Economics

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Abstract: *Electronic cash systems, such as **Mondex** and **ecash**, seek to re-engineer cash payments. While the use of cash imposes numerous invisible costs on the economy, numerous security and consumer acceptance issues prevent its immediate replacement. The major challenges in the global implementation of electronic currency will be establishing the proper incentives for channel members, regulatory barriers, and gaining critical mass of consumer and merchant acceptance rather than difficulties with technology or network security. Furthermore, entry and competitive dynamics in cash-intensive service industries will be significantly enhanced with the widespread adoption of electronic cash. New opportunities for*

financial-services providers will arise, even as traditional brick-and-mortar branches decline precipitously in importance.

1. Introduction

As a store of value and means of exchange, cash is king. At first examination, it seems the least complicated, least costly, and most universal method of payment recognized by the 1990s economy, despite having existed for thousands of years. Processing cost for cash payments appears (somewhat deceptively) to be quite low compared to that of checks, credit cards, or direct billing on account. Cash is recognized as a form of payment in many business operations that accept no other, and many person-to-person obligations are settled with cash. In addition, cash has a very quick (if not infallible) "speed of authorization." It requires only a fraction of a second to recognize a bill, and although it may be a challenge to determine whether a given \$100 bill is genuine, it is certainly more difficult to forge a U.S. Treasury note than to write a check on a defunct account. Cash is convenient and easy to use, and its adoption is absolutely universal. In particular, small transactions are most easily accomplished with cash, and this ease translates into an impressive market share for these small transactions: it is estimated that, of the annual \$360 billion in U.S. cash transactions, 75% (\$270 billion) is made up of tiny transactions under \$2 each, in obviously vast quantities. [UK figures are similar: £7.6 billion in cash transactions under £5 comprise over 60% of all cash transactions.]¹

1.1. Why Reengineer Cash?

When cash works, it works well. To reengineer cash, we would have to replace the familiar form of banknotes and coins with a new technology while retaining—or enhancing—cash's old functions of low transactions costs, transaction speed, partial anonymity, and high acceptance. Why replace King Cash? Four major reasons exist: reducing handling costs, improving ease of use, eliminating high costs of infrastructural support, and enabling new avenues for distribution. First, the actual handling costs of cash—including costs of securing cash from dishonest employees, opportunity costs of foregone interest, rolling coins, and so forth—may significantly exceed costs of checks or of credit cards, which provide easy methods of security and float management at the expense of authorization time and post-transaction processing. NatWest Bank estimates that these costs of handling cash within the UK add up to a staggering £4.5 billion annually, £2 billion of which is borne by consumers. In addition, the anonymous nature of cash (especially

"small, unmarked bills") leads to an enormous problem with theft, as the thief can anticipate easily respending the cash with low probability that his use of stolen bills will lead to his capture. Just this desire to protect against theft has led to the proposed introduction of VISA stored value cards, a disposable card which can be converted into cash at any ATM but which is valueless (and thus potentially cancelable and refundable to the rightful owner) without the accompanying PIN.²

Second, while cash is as easy to use in the United Kingdom as in the United States, "cash" varies from country to country. "Cash" as a global concept, rather than a single currency, is really a network of dozens of currencies, which are mutually exchangeable only in a small fraction of the establishments that accept some form of cash. In addition, the concept of "exact change," a prerequisite for trading with many 20th-century vending machine, occurs only with cash. Any traveler who's experienced the frustration of holding 90¢ in coins and a \$1 bill and attempting to purchase a 95¢ soda from an airport vending machine that demands exact change knows the problem: cash is not infinitely divisible, nor does having "enough cash" guarantee being able to complete a transaction. Coca-Cola estimates that 20-25% of potential sales are lost by not being able to match the desire to purchase its product with the means to do so; exact change comprises a large percentage of this "lack of means."

Third, the indirect costs of maintaining the infrastructure necessary to support widespread use of cash are considerable. Check-cashing establishments and armored trucks, for example, provide no social value other than the dispensing and protection of cash. Although ATMs offer information about a cardholder's account in addition to dispensing bills, the most common transaction at an ATM is the withdrawal of a small amount of cash—necessitating not only the use of a complex piece of electronic machinery but also time spent waiting in line at 5:00 on Friday afternoon. Vending machines set up to process coins and bills need to be periodically emptied (and restocked with change, if frustrated consumers are to be avoided.) Some businesses are net producers of change, others net users of it; physical transport of these pieces of metal from producers to users consumes time and energy without creating any new products. In addition, changing prices of vended products can be accomplished dynamically from off-site, as configuring vending machines for slightly different protocols for acceptance of electronic currency is an easier engineering task than

reconfiguring them for new coin combinations.

Lastly, the change in cash payment from a physical transfer to a pure information transfer will support cash payment for services marketed electronically. Although Mondex, a commercial electronic cash system currently in test markets, is targeted at existing uses of cash, it is the still-undeveloped market for electronically-aided commerce that provides the impetus for most of the other proposed electronic cash systems. This paper will focus on the strategic impacts on market entry, competition, and pricing strategies of introducing electronic payment into previously cash-bound settings.

1.2. Potential Benefits from Reengineering Cash

What is electronic cash?

Simply speaking, an electronic cash system is any electronic means for transferring information that replaces physical (i.e., banknotes and coins) cash transactions on a one-for-one basis, or that mimics the unique properties of cash as a medium of exchange (i.e., anonymity, lack of proof of payment, and so forth).

An ideally designed system of electronic cash offers enormous potential benefits to consumers and merchants, as described in BusinessWeek [1995]. Consumers can clearly save time in transactions by using a card rather than fumbling for change, and by omitting those twice-weekly trips to the ATM. Person-to-person debts could be quickly settled by direct transfer. An automatic record of all cash expenditures could be captured in real time and later analyzed, either for reimbursement of expenses or for analysis of spending patterns, much as some of today's premium credit cards categorize expenses on a yearly basis.

Merchants—especially vending machine operators—can capture sales that previously couldn't be completed. Revenues would be instantaneously transferable from a card or electronic till to a bank account, leading not only to increased interest revenues on deposits but also a greatly reduced supply of cash on hand and thus a corresponding reduction in risk of theft.

The originator of the electronic cash that drives the system can also retain some portion of the benefits without necessarily increasing costs to either consumer or merchant, by taking advantage of the "float." Much as the issuer of a traveler's check today has free use of the money the check represents until the

check is actually redeemed, the originator of "electronic dollars" (or "electronic yen," for that matter) may (depending on the design of the system) have free use of the real dollars exchanged for them until the electronic dollars are returned for redemption. This process potentially can take forever, as recipients can respend them instead of redeeming them. For purposes of illustration, the value of the "float" on the aforementioned \$270 billion of less-than-\$2 transactions, assuming an 8% risk-free return and an average length of float of two weeks, is \$831 million per year. The originator earns interest on the float (in effect, a rental fee for the electronic units) during the time when these electronic units are in circulation among consumers. When the electronic units are returned, the originator redeems the electronic units for physical units, completing the cycle and ending the float. In addition to gaining the interest from this float, the electronic cash organizer can potentially negotiate licensing revenues from banks authorized to issue electronic money.

Banks participating in the electronic cash network, charged both with clearing transactions and with "dispensing" electronic cash, can realize both offensive and defensive strategic benefits. By offering such a service when competitors do not, a bank can differentiate itself, leading to a gain in market share (competitive advantage); conversely, offering such services in parallel with competitors guards against share loss even when no advantage is forthcoming (strategic necessity). As will be seen, future entrants in banking will likely render electronic cash services a strategic necessity even if no current banks force the issue.

1.4. Factors Affecting Success

The key issues affecting success of a commercial electronic cash system are not simply whether the benefits from the product will exceed the costs of its creation assuming that it is adopted, but rather issues of channel coordination, consumer acceptance, and merchant acceptance. The feasibility of the initial business case rests on gaining a critical mass of consumer and merchant acceptance. Initial data on consumers' willingness to adopt this technology from a market-research interview environment is strong.³

Data from a live test-market environment are expected to be forthcoming from Mondex's July 1995 roll-out in Swindon, a UK city of population 170,000. Over 1,000 merchants—including McDonald's,

Sears, British Petroleum, Laura Ashley, Sainsbury's, Post Office counters, Thomas Cook Travel, and Ladbroke's betting parlours—participated in this test market without any compensation from Mondex other than experience gained. Although Mondex covered all costs from this test, the eventual long-term allocation of benefits among the originator, the member issuers, merchants, and customers will depend crucially on strategic geometry, market alternatives, and the structure of competition at the various levels of the channel. The ultimate economic success of any electronic cash system, viewed from the perspective of the creator of the cryptography system and/or the franchiser of distribution rights, will thus depend upon channel power and considerations that regulators and central bankers have not yet formally addressed. When Alan Blinder, Vice Chairman of the Federal Reserve Board, was asked about his views on digital cash as recently as February 1995, his response was, "Digital what?"

2. Review of Mondex Operations

From the perspective of users (that is, consumers and merchants) Mondex looks like a credit or debit card and operates like cash. Rather than visit an ATM to retrieve physical cash, a Mondex user places cash value on his or her Mondex card (powered by a specialized Hitachi H8/310 series microprocessor) by transferring money from an identifiable bank account; these transfers may be done either at a bank or by using the special hardware of a Mondex-equipped telephone. Once the card carries a cash balance, the user can present the card as a form of payment at a Mondex-accepting merchant, with the amount of the purchase automatically transferred from the card balance to the Mondex till of the merchant, from which it can be uploaded to the merchant's bank. Mondex transactions of this type are entirely "off-line": at the time of transaction, balances are shifted from one card to another without waiting for a verification from a central database. This off-line status allows transactions for small amounts of money to be made as quickly as with cash, if not quicker. These benefits led to Mondex being voted the "Most Innovative Smart Card Accomplishment of the Year" at the 1994 European Smart Card Applications and Technology Conference in Helsinki.

Once transferred to a card, each Mondex cash unit is totally interchangeable with any other (even more so than cash, because Mondex currency does not bear serial numbers like physical bills),

making the user anonymous for all practical purposes if desired. Detailed central accounting of individualized transactions is neither necessary nor possible, facilitating speed of payment and keeping costs low. Individuals' requirements for personal record-keeping are handled by an "electronic wallet" containing a chip, which could theoretically record thousands of transactions for reimbursement or budget analysis. It should be noted that this decentralized record-keeping leaves the onus on the buyer to prove payment (much like cash.) Individuals' records are as secure as the individual desires; the card can be locked, using a PIN, to prevent unauthorized withdrawals or snooping. Thus, while the value on the card can be conveniently accessed without a PIN during the normal course of a transaction, the consumer can also lock the card when not actively using it, protecting large amounts of stored value from theft.

One special feature of the Mondex system that differs from a traditional credit or debit card, for example, is that value can be transferred from card to card. Before Mondex, physical cash was the only medium of exchange that could instantly effect such a transfer. Mondex-equipped telephones, a component of the system necessary for the "refueling" of cards from bank accounts, offer public access to this technology even to two walletless individuals. Every public phone would conceivably double as an ATM. As person-to-person credit and debit cards have yet to be introduced, Mondex's opportunities in this market are potentially great.

As noted above, detailed accounting of the movement of individual units of electronic currency through tracking individual consumer transactions is neither possible nor necessary. Similarly, detailed accounting of the issuing source of electronic currency is not necessary, provided that (1) the issuer does not issue electronic units without collecting physical currency (or equivalent value), and (2) the electronic monetary system is closed, e.g., no "counterfeiting" of electronic money occurs, and electronic dollars are "destroyed" only when exchanged for physical dollars. Establishing this accountability in money creation and destruction may prove to be the greatest security issue of all.

2.2. Security Issues

The specifications for accepting Mondex transactions are public documents to encourage third-party development of complementary

hardware and software, but the cryptographic techniques for validating individual cards are understandably kept private for security reasons. While 100% off-line authorization ensures speed and cuts transactions costs, such a verification system makes the usual security questions even more critical: how do we know an electronic cash-bearing card is genuine before accepting money from it, and how do we know that the electronic dollars we're receiving are not counterfeit? And if these dollars should turn out to be counterfeit, who is liable for their replacement or loss of value? Such concerns can be addressed in two ways: through cryptography to deter outsiders from breaking into the system and through properly designed channel incentives to keep insiders honest.

2.2.1. Keeping Intruders Out: Deterring Counterfeiting

The question of "is this a legitimate card?" is more difficult to answer for off-line electronic cash cards than for smart debit or credit cards, which are uniquely identified by a number which must be tied at all times to existing customer accounts, which are subject to on-line authorization, and which can be effectively canceled by instructing the central database to withhold this authorization. The offline nature of the system precludes real-time card cancellation and on-line authorization; thus, every card must be able to recognize real electronic money and distinguish it from counterfeit. To address this challenge, the current Mondex security plan uses double-Rivest public key encryption to allow each card to swear to each potential acceptor, "I am an authorized card, with authentic value stored on me." Neither of the parties needs to demonstrate who he is, or which bank issued the card or provided the value. Each party need demonstrate only that their cards came from somebody who's been approved by Mondex International to issue them, and that their electronic cash is genuine.

The question of "Is the money that I'm receiving real?" might be difficult to answer on a cryptographic level, but may prove to be less important to consumers (and more important to central bankers) than originally thought. Bad electronic cash units, should they manage to get into circulation by some cryptographic means not yet envisioned, would by definition (and necessity) be perfect counterfeits: in the absence of serial numbers, all units that pass the extensive cryptographic screening engendered by the card-and-wallet system are perfect substitutes. Although it might be detectable that counterfeit units have entered the system if the

aggregate quantity of electronic currency units exceeds those authorized by the entity responsible for release into circulation, the individual counterfeit units may not be distinguishable from legitimate units in any way. While this poses a significant cryptography problem to prevent counterfeiting, the after-the-fact indistinguishability of counterfeit from legitimate does have a silver lining: a receiver of unmarked electronic cash units need not worry about whether the money he or she is receiving will be honored by the issuing bank (provided that counterfeiting is not so extensive that the issuing bank fails). As *all* units appear the same under scrutiny, consumer who have in good faith received counterfeit units cannot be discriminated against in any way—even without laws guaranteeing equal opportunities for reimbursement. Consumer and merchant acceptance is thus potentially bolstered by the same anonymity-of-units that gives fits to cryptographers (and, by extension, to issuing banks and governments).

2.2.2. Keeping Insiders Honest

The principal threats to the integrity of a monetary system augmented by electronic cash come not from the technological side (teen-age hackers with advanced degrees in cryptography using soldering irons and supercomputers in their garages) but from rogue issuers or originators (or rogue employees of honest issuers or originators.) Had Barings been a Mondex originator, for example, it would have been no more difficult, in theory, for Nick Leeson to cover his trading losses by covertly releasing unauthorized Mondex cash into circulation than by forging internal memos.⁴ The social problem of a rogue issuer or originator arises when we consider the long-term effect of these extra units on the electronic cash system. Like in any monetary system, an originator's injection of extra currency units into circulation without receiving any consideration for them, if undetected, causes inflation and devaluation of the existing legitimate units. [If detected, an offsetting "open-market operation" can be made by the currency's central bank, maintaining the integrity of the electronic currency unit, and the originator billed for the appropriate amount.] Although the legal interpretation of who holds liability for losses from counterfeit electronic money has not yet been formed, the willingness of originators to honor all electronic units as genuine—and to redeem them for cash—is critical to public confidence in an electronic cash system.

3. Unresolved Issues

Issues yet to be resolved include regulating the issuance of electronic currency, pricing strategies, implications for other forms of electronic currency money, and broader issues with virtual money.

3.1. Regulating Currency Creation

In addition to destroying the integrity of its own electronic monetary system, a serious breach of security might compromise the physical currency upon which the electronic form is based. National central banks are thus expected to be interested in (and, potentially, skeptical of) widespread commercially based applications of electronic cash that involve issuing currency units, and such issues of monetary regulation are still largely unresolved. In addition to protecting the integrity of their country's currency, central banks may feel threatened by electronic cash's ability to substitute in everyday transactions for paper money—in effect, competing with and reducing the government's ability to earn the float from selling currency to banks. Governments losing this ability to manufacture small pieces of paper and bits of metal and call it "money" (a process known as "seignorage") may experience a revenue reduction, even as the world as a whole captures enormous benefits by eliminating ten billion pocketsful of loose change. While society might embrace electronic money enthusiastically, there is thus no assurance that governments will be accommodating in allowing the free market to determine operating format, or in surrendering the right to perform seignorage.

Should seignorage be maintained as a nation-state prerogative in an e-money environment? The answer to this question depends on the structure of the agreement between a national bank and the issuer of a particular form of electronic currency. In general, governments and their constituents might well benefit from treating seignorage as yet another example of a traditional function of government that might be privatized, licensing the right to "print" electronic money to issuers, monitoring issuers' performance, and re-auctioning these licenses periodically to capture revenue that would otherwise be lost. A nation that holds fast to its exclusive right to effect seignorage as a matter of principle, in the face of economic arguments to the contrary, may find that the demand for its hard currency declining so precipitously that total seignorage

revenues fall below that which could be captured by a licensing agreement. The Bank of England works closely with Mondex, approving plans to issue electronic currency as such plans are proposed. It is hoped that a mutually beneficial relationship between national bank and e-money issuers can be maintained.

The question of seignorage is also tied to the question of money creation in a broader sense of controlling the instruments of monetary policy. While seignorage creates profits at the government level—the loss of revenue from which can be readily quantified—haphazard control over monetary policy creates repercussions in the economy as a whole which are more difficult to quantify. Inasmuch as the national bank values keeping control over monetary aggregates, there is no obvious reason why a well-structured and well-monitored contract (or, less formally, strategic alliance) between the national bank and the issuer cannot fully separate the issue of monetary control from the issue of seignorage. To leave monetary control in the hands of the national bank, the contract between national bank and issuer must include limitations on monetary creation even if the profits from incremental seignorage accrue to the issuer in return for a fee paid to the national bank. The national bank can then compensate, in its own operations to fine-tune monetary policy, for the seignorage performed by the licensed issuer.

3.2. Pricing Electronic Cash Services

While many different fee structures suggest themselves, the method that will be used for Mondex has yet to be released to the public.⁵ Opportunities to charge consumers include outright sales of cards or wallets; a monthly rental fee for the use of a card or wallet; a fee for each transfer between the card and an authorized bank account; or a small discount on the exchange between money and e-money (and vice-versa), similar to a retail foreign-exchange transaction.

Opportunities for collecting fees from merchants are similar; for example, the option to charge a fee to deposit money from a stored-value card to a traditional bank account (similar to a back-end load on a mutual fund). Redemption of electronic cash for physical cash will be a service vital to merchants but seldom used by individuals, and thus a way to charge different prices to these two groups. Much as Saturday-night stayover requirements separate business and leisure travelers, allowing the latter to enjoy low

airline fares while keeping average revenue high, redemption fees can separate merchants from individuals to collect revenue without discouraging individuals' adoption of the new technology.

Fundamental questions of market research remain: for example, will consumers actually pay to use electronic cash, and if so, how much? Experience with electronic home banking has not been encouraging (and has been downright painful to banks' bottom lines) while experience with travelers' checks has been both encouraging and profitable. Mondex's Canadian partners have suggested that a monthly rental fee of \$1.25 to \$3 would cover both a Mondex card and a keychain-carried balance reader.⁶ We don't yet know whether merchants will be willing to pay for offering or using this form of payment. Again, U.S. experience with debit card acceptance has not been encouraging, although U.S. and UK experiences differ. As a hybrid between the electronic banking and travelers' checks, acceptance of electronic cash remains uncertain. Published results from the July 1995 Mondex experiment in Swindon are eagerly awaited to answer these and other important questions about adoption of this technology, including basic issues of consumer and merchant acceptance. Issues such as "Will consumers actually accept this form of currency in lieu of a paycheck?" and "will merchants actually be willing to hand over hard goods for no physically apparent compensation, without even a signed paper charge slip to back them up?" cannot be resolved by modeling but will require actual experience.

The major impact of the Mondex experiment, besides showing interested parties that the system does indeed work in practice, has been greatly to accelerate competing systems' launch in test markets. It seems clear to potential electronic cash providers from conflicting lessons learned from general applications of information technology in financial services⁷ and specific applications in ATM networks⁸ that there are substantial benefits to being the first robust system to gain widespread acceptance—the assumption being that an electronic cash system that captures significant *initial* share will generate extraordinary profits as long as it can sustain a substantial share even if competitors eventually match its service.⁹ Whether this assumption, which depends critically on high expectations of customer loyalty, will be borne out in practice remains to be seen.

3.3. Extensions to Other Forms of Electronic Cash

The concept of virtual money as a store of value is not new, nor necessarily high-tech. A greenback is not the same as the goods or services for which it can be traded. The value of the plowing services, fertilizer production, and eventually ox-tail soup represented by an ox can be equated to the value of a stack of dollar bills, but the nature of the two assets are fundamentally different. (Economists would point out that the technical difference is that the value of an ox lies in *production*, whereas the value of a dollar bill lies in *exchange*.) Lighting a cigar with a \$100 check is not the same as doing the same with a \$100 bill; neither destroys value in the same way as does shooting (or, for that matter, cooking) an ox. Paper money thus represents virtual value the same way that electronic cash represents virtual paper money. By disintermediating the clumsy paper and metal representations of value, electronic money promises to reduce the frictional costs of exchange.

Other forms of virtual money that are "almost, but not quite" cash—ATM cards, credit cards, charge cards, phonecards, Washington D.C. Metro cards, winning racetrack tickets, certified checks, irrevocable letters of credit, bearer bonds, and so forth—are part of the daily lives of millions who nonetheless are forced to continue to use exact change at soda machines. Debit cards, especially, qualify as electronic virtual money in that once an item is purchased, the consumer need do nothing else (not even pay a monthly statement). In Europe, payment systems such as *Carte Bleue* or *Carte Bancaire* offer a noncash hybrid, employing PIN-based service and retroactive billing with a chip-based card. Operational costs of debit and prepaid chip cards are significant, however; break-even transaction size for magnetic-strip debit cards is \$20, for hybrid chip cards, \$15. Such transaction economics make these media viable only for the upper 20% of transactions, leaving a large unserved market segment at the \$10 and under level.¹⁰

Some new forms of virtual money have been proposed as means of payment for the Internet, an environment where value can be exchanged but not easily paid for. On the Internet, the required physical presence just isn't there for exchange of cash and the ability of individuals to accept credit cards is not readily available. First Virtual Holdings [<http://www.fv.com>] has begun to address the last problem by making a limited form of

VISA/MasterCard acceptance available to anyone—regardless of age, time in business, or product—who's willing to pay a one-time \$10 fee plus 2% of each transaction, with proceeds cleared 100% electronically into a pre-established bank account. DigiCash by [<http://www.digicash.com>], a Netherlands-based firm headed by cryptographer and noted electronic privacy advocate David Chaum, is testing a conceptual payment medium called *ecash*, an authenticated system designed to handle payments of very small amounts while offering near-total anonymity, although perhaps at the cost of security problems and slow response. Plans to use Mondex technology to make transactions over the Internet through a World Wide Web homepage [<http://www.Mondex.com/Mondex/home.htm>] linked directly to Mondex merchants are also in development.

Why have so many sorts of electronic cash services been proposed? First, different systems of electronic cash possess different properties that make them more or less suitable for particular transaction settings (e.g., in-person, over the telephone, or via e-mail or WWW on the Internet) or for different magnitudes of the amount of money (e.g., transactions for fractions of a penny, for a few dollars, or for many thousands of dollars).¹¹ This diversity of applications creates a wide variety of proposed systems to deal with them. There is no guarantee that a single system will ever exist to handle all of these different types, and opinions differ on the future sizes of each of these markets. Second, since no system has shown a clear superiority in practice over any other, the natural "weeding out" process of evolution towards a common standard or "dominant design" has yet to begin.¹² While many systems are currently proposed, only a few will ever be implemented on a widespread scale, and fewer still will survive.

3.4. Broader Issues with Virtual Money

One beauty of cash is the ability to purchase a 50¢ newspaper while walking by the newsstand without slowing down. The instantaneous speed of use of two quarters (if not fifty pennies) is difficult to equal. The value of this convenience to consumers, however, varies significantly with the nature of both the item purchased and the circumstances of purchase. Physical purchases in person (as in our newsstand example) impose great time pressure for rapid authorization, as waiting in person is also quite noticeably annoying after a few seconds. On the other hand, purchases of physical goods remotely (whether on-line or via phone or fax) provide ample time to verify customer payment validity at very low

cost without inconveniencing the customer. The merchant, bound by the relatively clumsy technology of physical delivery of the goods, has ample time to check the customers' legitimacy before giving up physical control over the goods. The few minutes required for a fully-automated inventory system to select the correct item, pack it in a box, address the Federal Express airbill, and ready the package for shipping is more than sufficient to verify a credit card even using techniques that would be considered unacceptably slow by on-line or in-person customers waiting for an authorization in real time.

At the other extreme, on-line purchase of low-value on-line services imposes the greatest need for immediate authorization, not only because the user is excruciatingly aware of fractional-second delays in an on-line environment but because once the service is delivered, fraud detection after the fact becomes irrelevant—the information provided is impossible to reclaim, and the amount owed is not large enough to justify the cost of legal recovery actions.¹³

The importance of total cost of using a particular payment system, made up of all of the transactions costs involved, also varies with the nature of the use. For low-value off-line transactions, the direct costs of positive and negative authorizations¹⁴ can be problematic if either requires on-line inquiry; as a percentage of the value of the transaction, the cost to the merchant of quick verification is prohibitive; the wait for slow verification, intolerable. For on-line interactive exchanges, however, a low-cost, time-intensive authorization method can begin as part of the login procedure and be complete as soon as the customer finalizes the order amount. Costs of security are also an issue; although cash is vulnerable to being stolen and pocketed (unlike most oxen), the difficulty of counterfeiting suggests that fraudulent transactions are fairly difficult to accomplish with electronic cash. Costs (and benefits) of being anonymous in a transaction also sway consumers' choice of payment methods: for some transactions (such as membership in the highest tiers of frequent flyer programs) it is to the consumer's benefit to be identified, whereas for others the consumer may wish to remain untraceable.

3.4.1. Effects on Financial Services

The prospect of widely accepted electronic cash affects the ease of entry into traditional financial services markets as well

as into electronic commerce. Given that withdrawals and deposits can now be made via telephone, the last reason for physical banking presence will vanish; no longer will a "bank" require investments in brick-and-mortar branches. The structure of account management and such mundane tasks as account administration, check clearing, and transaction processing can be outsourced; ATM privileges for customers can be provided through membership in one or more reciprocal networks; the occasional need for face-to-face sessions can be handled in nonbank buildings, much as many in-person mortgage applications are today processed in the customer's home or office. When the only essential value-added of a bank stems from its effectiveness in marketing and information management, potential entrants with these skills may find the last traditional barriers to entry in banking erased.

Increased potential for entry does not necessarily mean reduced profitability for financial institutions with established brands—only for those who refuse to alter their traditional product lines to include opportunities and strategic alliances previously precluded by the clumsiness of handling physical cash. A few classes of creative additional products that may arise:

(1) Products that leverage banks' reputations as iron-clad counterparties.¹⁵ Banks are more than just service providers; they're service providers with a reputation for not reneging on deals. As such, they make ideal counterparties in transactions—a role employed by banks since the institution of merchant letters of credit. How can banks rent out this reputation in a way that brings in current income without overly compromising the reputation's integrity?

(2) Products that allow banks to serve as outsourcers, specifically in areas which new financial service entrants will require services—managing clearing functions and account transaction processing, to name two. Many banks provide services only for their current customers (account holders) and don't even consider the opportunities to serve as the outsourced provider for transactions incurred by other firms.

(3) Co-marketing with technology firms, in the manner of large pharmaceutical companies' alliances with biotechnology firms. In addition to devising unique products which can be combined with innovative partner technology, banks can often selectively—and not necessarily—acquire these technology firms when necessary.

In pursuing "float" rental fees on units of electronic cash,

banks would be well served to find some way to collect "point of payment" information on *size* of payments (even if the payee is anonymous). Such information can form the backbone of a value-added service, to help customers and corporations plan how much cash they need on their cards—whether to market a service of electronic-cash management (in which cash on a card can be automatically "swept" into a short-term interest-bearing account overnight, only to be returned to the card in the morning) or to persuade consumers that renting more units than strictly necessary can be convenient (as well as profitable to the originator of the units). As each electronic dollar-equivalent distributed to a customer in electronic form earns interest as its rental fee, banks can now employ marketing tactics to increase this rental revenue in creative ways, according to this variant on the classic marketing "volume equation."

Volume of electronic cash outstanding = $v(a, b, c, d, e, f)$

a = number of users with cards [expected sign: +]

b = number of cards per user [expected sign: +]

c = number of uses per card per day [expected sign: +]

d = average value of transaction [expected sign: +]

e = cost for a withdrawal (fee + inconvenience) [expected sign: -]

f = cost of being caught short of cash [expected sign: +]

Some measures at increasing volume outstanding might be persuading customers to:

- carry more cash on their card to avoid having to "fill up" as often. Note that convenient replenishment of electronic cash cards is a double-edged sword in this case, as ultimate consumer convenience equals zero float profits for banks. Allowing fee-free large withdrawals, while charging for small withdrawals, can recover some of this loss while encouraging adoption;
- carry more than one card in their wallet (each holding some

amount of cash) for ease of accounting and budgeting (thereby increasing the number of cards per user, as well as the number of potential withdrawal charges);

- give children learning the value of money (or, for that matter, frequent recipients of petty cash in businesses) cards with certain restricted abilities [e.g., those without withdrawal privileges, with spending limits, or auditable by a special central wallet so that spending can be tracked; (increasing the number of users while giving value-added services)].

Many other opportunities for increasing the volume of electronic cash units in use suggest themselves as well.

In addition to changing the composition of customers' demands for banking services, the effects of electronic cash on the ability to start new businesses will mean that customers will be using the banking system in an increasingly large number of guises. For example, an increasing number of individuals will require multiple accounts to handle business transactions; an even greater number will require smart account-management services for their personal accounts. What customers won't need is to stand in line, either in the branch or at the ATM, to receive old pieces of paper with only symbolic value. It is up to the branches to prove that they provide more than merely a place in which to stand in line.

3.4.2. *Effects on Peripheral Markets*

The barriers to entry of security, collection, and the cash-flow burden of the accounting cycle can be overcome by smaller and smaller businesses, especially those who sell information as their primary product. First Virtual's \$10 introductory fee and a 2% collection fee compares favorably to activity-based costs of running an accounts receivable department, even for many large companies. Shareware payments for software initially distributed free of charge can be collected on-line, with codes to unlock advanced features instantly distributed. "Pay per view" information providers need only establish a reputation for accuracy, not a mechanism for collection (or even an address). Such transience can only encourage dynamic entry and exit, while creating a market for the service of "continuity for hire;" established institutions can act to guarantee the quality of information, leveraging their existing reputation.

For companies selling physical goods, dynamic discounting of

accounts receivable in return for electronic cash payment becomes technologically feasible; in addition to a standard discount for early payment (e.g., 2% for payment within 10 days), firms can negotiate one-on-one for instantaneous payment at any point in time. These flexible arrangements will lead to more accurate corporate short-term liquidity management [what used to be called "cash management"] and the creation of derivative markets for super-short-term interest-bearing deposits, similar to the "overnight rate" between banks.

3.5. Out on a Limb: Preliminary Assessment and Predictions

Mondex will have its hands full convincing customers that their stored-value card should be trusted with such vital tasks as receiving payment and storing pocket money. While its technology may be bulletproof and extensively tested, consumer adoption will likely proceed very slowly. Once customers are convinced, Mondex faces a long negotiation process of signing up local partners and deciding on a pricing/ease of use system that will encourage widespread use by making deposits and withdrawals inexpensive and convenient, but still encourages customers to maintain moderately large balances on their cards.

Credit cards, charge cards, and debit cards will be here for some considerable time. They possess good consumer and merchant acceptance now, and will continue to be used (in conjunction with physical presentment of the card as a means of payment) for in-person purchases. With PINs and smart cards, these forms can be used for on-line purchases of services as well. The current generation of Minitel, the French national information-services system, accepts *Carte Bleue* for payment. The greatest threat to the continued success of these methods is perhaps their current success. If current success leads to complacency, and a feeling that credit cards will always possess dominant market share in \$500-\$1,000 transactions, card issuers may find out about a competitor only when it's too late to take reasonable defensive action.¹⁶

First Virtual will grow into and remain a successful bit player (pun intended) in a relatively small niche, piggybacking on the payment-acceptance infrastructure provided by MasterCard and Visa and the widespread consumer recognition of these two credit-card providers as reputable intermediaries who can solve the problems of security and real-time authentication. Merchants too

small to afford a full-scale Visa/MC merchant account will benefit, but these small players taken in aggregate will not comprise a major market segment. Ultimately, if their security system offers fundamental advantages over other forms of transactions, First Virtual will be bought by America Online, Prodigy, the Microsoft Network, or some alliance of the above. If such fundamental advantage is not forthcoming, First Virtual's admittedly useful function will be quietly duplicated by dozens of competitors, eliminating its profitability.

DigiCash bv's *ecash* product remains, perhaps appropriately, an enigma. On the one hand, on-line accounting, even of very small transactions, is a technology developed in the 1970s for timesharing on mainframe systems. Just as users were billed per CPU cycle, pages of printer output, or minutes of connect time, users can be billed for newspaper articles *à la carte* [or compensated for viewing commercial advertisements] by the on-line service, with either a detailed monthly statement or direct debit of a preauthorized bank account or credit card. A vendor whose monthly volumes are too small for Prodigy to serve will likely also be too small for DigiCash. The carefully crafted anonymity of *ecash* is vulnerable to regulation; tax authorities will not let large amounts of cash flow about undetected without *some* party being accountable for its tracking. New theft possibilities are created by leaving money on a hard disk that's left in the office overnight, rather than in a wallet that's carried on one's person at most times. On the other hand, *ecash* may yet prove to be the ideal tool for paying for services not yet envisioned—but there's simply no significant market for *ecash* as a unique, privacy-preserving technology in the immediate future if alternative electronic cash systems can achieve critical mass.

4. Conclusions

In the presence of broad-based change in payment worldwide, it would be naïve to assume that cash will continue to be the dominant means of making small, in-person payments. Rapid changes in the UK system for periodic, predictable payment have led to the typical UK bank customer writing only 4-5 checks per month (as opposed to 25-30 for U.S. households), with the remainder of normal transactions handled by direct debit. Similarly, transactions that in the U.S. would be handled with cash or credit card are handled in France by check (even for very small transactions) or *Carte Bancaire* (even

for very small and large ones).

There will be a continuing need for small, off-line transactions and a role for stored value cards. There will also be a rapidly increasing need for a payment system to handle Internet transactions: at present it is difficult to predict who will control this market. Whether this market will be eventually claimed by one or more of the traditional competitors such as MasterCard/Visa or major banks or by new competitors such as Mondex or *ecash* remains to be seen.

Endnotes

¹ Both U.S. and UK figures are from Mondex, "Towards Global Electronic Cash," Tandem Finance Industry Forum (Orlando, FL); January 19, 1995.

² Visa plans to test its product at the 1996 Summer Olympic Games in Atlanta, in cooperation with NationsBank, First Union, and Wachovia. See Greenberg, L.M. "U.K. Smart Card Wins a Foothold in North America." *The Wall Street Journal*; May 15, 1995.

³ For more details on preliminary market research on the acceptability of electronic cash, please refer to Clemons, E.K., D.C. Croson, and B.W. Weber, "Reengineering Money: The Mondex Stored Value Card and Beyond" [Working Paper 95-06-03, Department of Operations and Information Management; Wharton School of Business, University of Pennsylvania; June 1995.]

⁴ Wells, Joseph T. "Financial Frankensteins." *Internal Auditor* 550:2 (April 1993), pp. 52-57. See also Schmerken, I. "Lessons from Leeson." *Wall Street & Technology* 12:12 (April 1995), p. 6.

⁵ The information contained in the following sections comes entirely from analysis of publicly-available sources, and should not be taken in any way as anything other than an academic's enumeration of potential policies for pricing electronic-cash services.

⁶ Partridge, John. "Rental Fees in Works for Smart Card Users." *The (Toronto) Globe and Mail*; May 13, 1995.

⁷ Clemons, E.K. "Information Systems and Sustainable Competitive Advantage." *Information & Management* 11 (November 1986), pp. 131-136.

⁸ Clemons, E.K. "MAC-Philadelphia National Bank's Strategic Venture in Shared ATM Networks." *Journal of Management Information Systems* 7:1 (Summer 1990), pp. 5-25.

⁹ For a counterexample, see Clemons, E.K. and M.C. Row, "McKesson Drug Company: A Case Study of Economost." *Journal of Management Information Systems* 5:1 (Summer 1988), pp. 36-50.

¹⁰ Transaction time also becomes an issue: debit cards require 7-8 seconds to complete a transaction, compared to 12 for cash and 63 seconds for a traditional check. Initial tests of Mondex indicate a far superior transaction-completion time [Clemons et al., 1995; *op. cit.*]

¹¹ For more details about matching the technical means of exchanging cash with appropriate types of transactions to be so organized, see Camp, L. Jean, "Opportunities, Options, and Obstacles in Electronic Commerce" Columbia Institute for Tele-Information Working Paper Series. Presented at CITI conference "The Future of Electronic Banking" on October 23, 1995.

¹² For more on the process of evolving towards dominant design, see McKenney, J.L. *Waves of Change*. Boston: Harvard Business School Press, 1995.

¹³ For tips on inducing settlement to make partial recoveries in such "hopeless" cases, see Croson, D.C. and R.H. Mnookin, "Scaling the Stonewall: Using Lawyers to Boost Credibility." Forthcoming, *Harvard Negotiation Law Review*.

¹⁴ In this context, a positive verification checks to see whether enough purchasing power remains on the card to complete the requested transaction. A negative verification checks to make sure that the card has not been canceled or reported stolen. Most current credit and debit card systems build both positive and negative verifications into routine transactions, at the cost of processing time.

¹⁵ For more on using established business as "information brokers" or "stores of reputation", see Croson, D. C. "A New Role for Middlemen: Centralizing Reputation in Repeated Exchange." [Working Paper, Department of Operations and Information Management; Wharton School of Business, University of Pennsylvania] and Resnick, P., R. Zeckhauser and C. Avery. "Roles for Electronic Brokers." [Twenty-Second Annual Telecommunications Policy Research Conference, October 1994.]

¹⁶ For more on this phenomenon, see Clemons, E.K., D.C. Croson, and B.W. Weber, "Market Dominance as a Precursor of Market Failure: Emerging Technologies and the Competitive Advantage of New Entrants." Working Paper 95-06-02, Department of Operations and Information Management; Wharton School of Business, University of Pennsylvania; June 1995. Forthcoming in *Proceedings of the XXIX Hawaii International Conference on System Sciences*.