Shopping without cash: The emergence of the e-purse

Carol L. Clark

Introduction and summary

During the 1990s, some payment analysts suggested that smart cards[1] with e-purse applications could be a promising new payment option for certain types of transactions. An e-purse is a stored-value payment device that offers the following features to the consumer: It holds electronic monetary value that substitutes for cash; it does not require online authorization; it records the value of each purchase on the card rather than a central computer server; and it can be exchanged for goods and services from various merchants. The device is generally stored on a computer chip, which can reside on any one of a number of items most consumers already carry, such as a payment card, mobile phone, key chain, or even a watch. When the consumer makes a purchase, monetary value is deducted from the microchip on the card.

The key difference between a stored-value smart card and debit, credit, payroll, and gift cards is that value is stored directly on the smart card rather than stored in an account on a central computer server, and therefore, transactions are processed offline between the smart card and the card reader at the point of sale (POS). In contrast, debit, credit, payroll, and gift cards in the United States are offered on magnetic stripe cards, and payment involves an online authorization that requires a real-time connection with a central computer. The purchase is approved or declined through the authorization process, which checks whether there is sufficient value in the account for debit, payroll, and gift card transactions and whether the credit limit has not been exceeded for credit card transactions. The authorization process may also check whether the card is fraudulent or stolen.

Some payment analysts predicted that smart cards could lead to a cashless society, one in which e-purses would replace cash and coins for low-value payments. As we know, this hasn't happened. Although a number of e-purse programs have been implemented around the world, these programs have experienced varying degrees of success, and many have failed outright. Smart card adoption in the United States has been slower than in the rest of the world. Many analysts argue that this is partly because the U.S. already has an advanced telecommunications infrastructure that can verify magnetic stripe card transactions quickly and cheaply online. This results in relatively low fraud levels and relatively high levels of satisfaction among businesses and consumers with the current systems. If this is true, then smart card applications may offer more value in other parts of the world with less highly developed telecommunications infrastructures and higher incidences of fraud in existing payments networks.

In this article, I review six e-purse smart card programs in Hong Kong (one) and the United States (five). I chose these two regions because Hong Kong has one of the most highly successful e-purse programs, the Octopus card, and the United States has implemented a number of e-purse programs, some of which have been more widely adopted than others. I find that the most successful among these programs tend to have the following characteristics: a captive audience that drives critical mass, such as those found in the transportation industry or government sector; an affordable cost structure relative to other payment instruments; compelling incentives to consumers and merchants; and a technology that is well tested and addresses standards issues before the rollout.

Carol L. Clark is a payments research manager at the Federal Reserve Bank of Chicago. *The author gratefully acknowledges the assistance of Erin Davis, Juan A. De Jesus, David Doyle, Tamara Kidder, Graham Mackenzie, John Scaggs, Barbara Straw, Eric Tai, and Joey Wong in the completion of this study and the helpful comments on previous drafts by Sujit Chakravorti, Geoffrey Gerdes, Richard Porter, Tara Rice, and Leo Van Hove.*

Below, I survey the theoretical framework of previous smart card studies, provide an overview of the payments environment in Hong Kong and the United States, and analyze six e-purse programs in these two regions and the factors that contributed to their success or failure. Then, I discuss the implications of my findings for future e-purse programs.

Literature review

One of the greatest challenges in the adoption of a new payment device is establishing a critical mass of users. Regardless of the type of technology used, consumers are reluctant to use a new payment instrument if few merchants accept it, and merchants will refuse to accept the device because the cost of installing and maintaining the supporting technology infrastructure, like card readers, may be prohibitive, unless enough consumers want to use it. New payment mechanisms gain momentum when enough people use them, which leads to widespread acceptance by the merchant community. Critical mass, however, is not only related to the number of users but also to the actual levels of usage because the program's profitability is generally dependent on high transaction volumes (Goldfinger, 1998). As Rochet and Tirole (2003) observe, merchants cannot benefit much from consumers that hold a payment card but use it only sporadically. The more frequently the card is used, the more valuable it becomes to consumers and merchants. Therefore, frequent use is one of the keys to a successful e-purse program.

Goldfinger (1998) estimates that a critical mass of one million users was needed for a smart card program to attain profitability due to the large fixed costs of the infrastructure, although these costs have likely fallen in recent years.[2] To achieve this, Goldfinger argues that program promoters have to be able to orchestrate a large-scale deployment and initiate a migration/switching process from the existing payment system to the smart card system. He takes the view that the benefits that smart cards provide cannot be fully realized if there is an alternative payment infrastructure present. While this is certainly not the case for mature payment infrastructures—cash, checks, debit cards, and credit cards coexist at most retailers—there may be some validity to this argument in the case of an emerging payment instrument like an e-purse.

In another study, Van Hove (2004) examines data on 16 e-purse systems in Europe. Van Hove finds that successful programs are in countries that are relatively small geographically or have phased introductions; that have online debit card systems that are fairly popular or cannot be used for low-value payments; that have stakeholders that quickly agree on a common solution so there are no incompatibility problems; that have major banks committed to and participating in the program; and that have support from key players that operate and support one or more of the following: public telephones, parking meters, vending machines, or public transportation.

Chakravorti (2004) finds three other necessary conditions for a viable new payment instrument: There must be benefits that are not provided in existing payment instruments for at least certain transactions; consumers and merchants must be convinced of these benefits and, possibly, provided with incentives to change their behavior; and the new system must be perceived as secure, with adequate measures against credit risk and fraud.

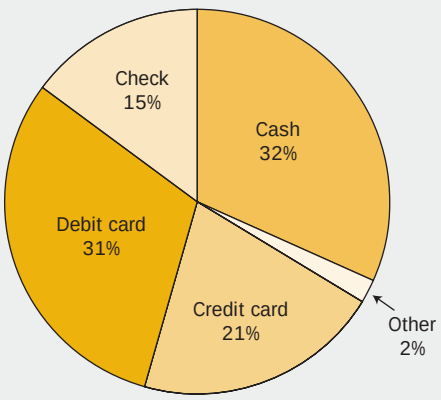
Payments environment in Hong Kong and the United States

As I explained in the introduction, I am interested in comparing programs in Hong Kong and the United States because Hong Kong has one of the most highly successful e-purse programs, the Octopus card, and the United States has implemented a number of e-purse programs with varying degrees of success. As figure 1 shows, Dove Consulting (2003) reported that in 2003 electronic payments surpassed other types of payments for in-store purchases for the first time in the United States. However, cash was still the most popular payment vehicle.

Cash is used even more widely in Hong Kong. Eric Tai, chief executive officer of Octopus Cards Ltd., indicates that Hong Kong residents use coins

FIGURE 1

How U.S. consumers made in-store payments, 2003



Source: Dove Consulting (2003).

and currency 50 percent of the time. Checks are used for retail transactions, where credit and debit cards are not accepted, and credit cards have become increasingly popular, with over nine million in circulation in 2001 (Bank for International Settlements, Committee on Payment and Settlement Systems, 2003). Interestingly, however, in Hong Kong, e-purse transactions are now growing faster than either debit or credit card transactions—Euromonitor International (2004) reports that they increased by 8 percent in 2003, compared with 7 percent growth in debit card transactions and 2 percent growth in credit card transactions.

While the United States and Hong Kong have each implemented a number of e-purse programs, only Hong Kong's Octopus card, which began in the niche transportation industry and extended outward to retailers, has been widely adopted by consumers and a diverse number of merchants. More than 95 percent of Hong Kong's residents aged 15–65 carry the card. Over 50,000 smart card readers accept Octopus at public transportation terminals, convenience stores, fast food chains, leisure facilities, parking meters and garages, pay phones, personal care stores, photo booths, photocopiers, school snack shops, supermarkets, taxis, and vending machines (Tai, 2005). In August 2005, Octopus announced an apparel retailer will accept the card at its Hong Kong locations. Some e-purse programs in the United States that began in niche markets are currently successful, but on a much smaller scale.

Octopus processes over nine million transactions each day with an average daily transaction value of about HK$65 million (US$8.3 million) amounting to about 2 percent of Hong Kong's gross domestic product (GDP) in 2003 (U.S. Department of State, Bureau of East Asian and Pacific Affairs, 2004).[3] Retail purchases in Hong Kong using the Octopus card grew from 5 percent in January 2002 (Trintech Group Plc, 2003) to 17 percent of total transactions in August 2005 (Wong, 2005). With about US$1.4 million in average daily retail transactions, Octopus takes in more in a single day than the widely reported Mondex and Visa Cash trial in New York City did during the entire 15-month program.[4]

As I mentioned earlier, most payment analysts agree that smart card adoption in the United States has been slower than in the rest of the world because the United States has an advanced telecommunications infrastructure that can verify magnetic stripe credit and debit card transactions quickly and cheaply online. This results in relatively low fraud levels and relatively high levels of satisfaction among businesses and consumers with the current systems. Smart card applications may offer more value in other parts of the world with less highly developed telecommunications infrastructures and higher fraud incidences.

The business case for smart cards in the United States also depends on a number of other factors. There are issues related to who would pay for the extra chip on the card and to what fees merchants would pay on a per transaction basis. In Hong Kong, merchants appear to be paying lower rates on Octopus transactions than on credit card transactions.

There are also differences in the technology used for stored-value cards in the two regions. Octopus provides e-purse capabilities on a contactless smart card, which means the card does not have to be inserted into a card reader like credit or debit cards. Instead, it is held close to the reader and payment is registered in 0.3 seconds. Meanwhile, Duetto cards offered by the coffee chain company Starbucks, payroll cards that are used instead of direct deposit or paychecks by some firms to deliver an employee's pay, and gift cards offered by various retailers in the United States provide stored-value capabilities on magnetic stripe cards. There are two ostensible reasons for using magnetic stripe cards rather than contactless smart cards in the United States: the cost of equipping stores with chip reading terminals and the desire to include Visa, MasterCard, or private label branding since these cards are processed by online readers.[5] In addition, some payment providers in the United States offer contactless smart cards but link purchases to credit card or debit card accounts rather than to an e-purse—examples include ExxonMobil's SpeedPass, Bank of America's QuickWave, and MasterCard's PayPass. In an interesting development, in December 2004, the Washington Metropolitan Area Transit Authority began piloting 20,000 MasterCard branded magnetic stripe cards that also contain a stored-value chip for transportation (Garback, 2005).

Case studies

I examine six e-purse case studies that began in "closed-loop" environments in Hong Kong and the United States, meaning they were offered to what one might call a captive audience, such as one found in a military facility or university campus. The e-purse programs that were tested in open-loop environments in these two regions have failed outright, such as the Mondex and Visa Cash trial in New York City cited previously.[6] I chose the case studies to represent a cross section of industries that have implemented e-purse programs in recent years: transportation, government, and higher education. The Octopus card's e-purse transaction volumes and values are among the highest in the world. The Ohio Electronic Benefit Transfer program, which has higher transaction values and volumes than

Octopus, is the largest smart card program for administering food stamps in the United States. The University of Michigan Mcard represents one of the largest university deployments of an e-purse in the United States. The University of Central Florida UCF Card is one of the few campus e-purse programs still in operation. The Navy Cash™ card and the EagleCash card programs are two of three smart card programs administered by the U.S. Department of the Treasury for the U.S. Armed Forces. A synopsis of the six programs, as well as a detailed discussion on how each card works, is included in the appendix.

Octopus card

The Octopus card began in the niche transportation industry when Hong Kong's five leading companies for trains, buses, ferries, and subways formed a joint venture in 1994 to oversee the implementation of a smart card system. After three years of development and trials, they launched Octopus in 1997. In 1999, 7-Eleven stores in Hong Kong became the first locations outside the mass transit system where riders could add value to cards. The convenience store chain liked the speed and ease of the contactless technology so much that it installed readers in its stores in the following year so that consumers could pay for goods using Octopus. In time, consumers began to press other retailers to accept the card as well (Ramstad, 2004).

A number of factors were crucial to the success of the Octopus card: the support of five transportation companies; the interoperability of the system; the manner in which critical mass was established by leveraging the captive and niche transportation industry; the reliable technology; and the compelling incentives offered to consumers and merchants.

Factors influencing success

Octopus has the support of Hong Kong's five major transportation companies. Although some of these companies compete directly for riders, the savings they achieved by implementing a shared smart card system appear to have outweighed any competition concerns (Poon and Chau, 2001). This also implies that the profit-sharing scheme the transportation companies worked out is equitable enough to induce cooperation. For consumers, the development of a single interoperable system means they can access any public transportation in Hong Kong with the same card. In contrast, 40 miles from Hong Kong in Macau, two bus companies launched separate incompatible e-ticket systems that failed to reach critical mass because traveling in the area typically requires a combination of buses and most people were not willing to carry two different cards (Uzureau, 2003).

Octopus has also been free of technology-related problems, unlike several smart card programs that have had trials in the United States. Very few failures of the Octopus card were reported during the first month of operation. On average, station personnel needed to resolve problems in only one out of every 11,000 journeys (Wynne, 1998).[7]

Octopus also uses radio frequency identification (RFID) technology, which allows commuters to wave their card (or a purse or wallet containing the card) within 4 inches of the reader at the ticket barrier to register payment within 0.3 seconds (BusinessWorld Publishing Corporation, 2002). Thus, an Octopus card transaction takes less time than a cash transaction in which one may have to wait for change, and takes significantly less time than the typical credit or debit card transaction in which magnetic stripe technology is used. Moreover, the durable smart cards have a potential life span of about 100,000 transactions (Tai, 2005). And Octopus's functionality has been embodied in a variety of forms, including key chains, mobile phones, and watches.

What about incentives? Initially, Octopus offered consumers a 10 percent savings and a 100 percent satisfaction guarantee to increase adoption in the transportation sector and to remove uncertainty about the new technology (Tai, 2005). These incentives, along with the simplicity, speed, and convenience of the system's technology, resulted in over three million cards being issued during the first three months and established a critical mass of smart card users who were familiar with RFID technology.

Metro and rail transportation operators offer multiple ride tickets on the Octopus card and single ride tickets on magnetic stripe cards (Wong, 2005). This is significant because over 70 percent of Hong Kong residents use some form of public transportation each day (Poon and Chau, 2001) and are more likely to use the multiple ride tickets offered by Octopus. Tai (2005) reports that constraining multiple ride tickets to Octopus cards elicited little consumer dissatisfaction. Metro and rail transportation operators provide discounts to Octopus cards over single ticket cards; the discounts vary according to the distance traveled. Smart card adoption for metro riders is 90 percent and for rail commuters over 80 percent (Wong, 2005).

Transportation operators for buses, minibuses, and ferries accept coins or Octopus cards, and fares are the same for each payment method. Octopus card adoption on these transportation lines is somewhat lower compared with the metro and rail lines—70 percent for ferry lines, about 80 percent for minibuses, and over 80 percent for buses. Although buses, minibuses,

and ferries do not consistently offer a discount to Octopus cardholders as do the metro and rail lines, they do sometimes launch promotional campaigns that offer discounts to Octopus cardholders only.

Once a critical mass of smart card users was established in the transportation industry, the proven technology was used to branch out into the retail market, where consumers were offered a number of benefits that helped foster adoption. Octopus is a single convenient, multipurpose card that speeds retail transactions and replaces cash for small purchases. In contrast to other e-purse programs, Octopus actually allows cardholders to make purchases up to a negative value of HK$35 (US$4), so long as the card contains a positive value of HK$0.01 before the purchase. Once the card has a negative value, it must be reloaded before it is used again. Octopus recovers the negative balance through the deposit and purchase price of the cards. For a detailed discussion of the types of Octopus cards, deposit amounts, and card costs, see the appendix.

Merchants also enjoy a number of benefits. Octopus reduces cash handling and in-store queues, and increases customer loyalty by allowing merchants to offer ad hoc discounts to customers using the card. It is difficult to determine the cost to retailers of accepting the card, since data on hardware costs and merchant fees are confidential. The World Bank's website indicates that Octopus has a two-part transaction fee. There is a HK$0.02 charge for every transaction to cover the costs of technical support, computer operations, and replacement cards and a 0.75 percent charge on the transaction value to cover card-control operations, legal, marketing, and depreciation costs. Therefore, a HK$10 transaction would include a fee of HK$0.02 plus HK$0.075, or HK$0.095 (Rebelo, 1999). However, Octopus Cards Ltd. has indicated that these transaction charges vary depending on merchant volume (Cheng, 2004).

Despite the uncertainty about exact costs, it appears likely that retailers in Hong Kong benefit from lower transaction fees for the Octopus card relative to transaction fees for credit cards, which vary from 2 percent to 4.5 percent (Morgan and Snee, 1997). Although new locations like McDonald's are accepting Octopus (Tai, 2005), some merchants still find Octopus fees to be too expensive. In *CardTechnology,* Balaban (2005) reports that a few retailers like Starbucks have reduced the number of outlets that accept Octopus.

Ohio EBT program

In the United States, the U.S. Department of Agriculture, Food and Nutrition Service (FNS) has shifted qualified low-income families from paper food stamp coupons to electronic benefit transfer (EBT) cards. The EBT program was designed to reduce fraud, to eliminate the cumbersome manual processes associated with issuing and redeeming paper food stamps, and to lessen the stigma associated with being a traditional food stamp recipient. In 2003, 9.1 million U.S. households redeemed an average of $1.7 billion in food stamps every month using EBT cards. To reduce fraud, the system creates an electronic record of each transaction that can help identify where food stamps are trafficked or exchanged illegally (U.S. Department of Agriculture, Food and Nutrition Service, 2004).

States have taken different approaches to administering the EBT program. Forty-eight states have implemented magnetic stripe systems that require online authorization from a host computer that keeps track of value. Two states, Ohio and Wyoming, use offline smart card systems that store value on a computer chip resident on the card. The state of Ohio has announced, however, that it is discontinuing its smart card program, Direction Card, which has been in place since 1996, and is seeking bids for an online system (Welsh-Huggins, 2003).

Factors influencing failure

John Scaggs (2005), Ohio's EBT project director, indicated that the decision to discontinue Ohio's offline system was based on cost, as well as on the failure of credit card companies to build a smart card infrastructure, which had been anticipated when the program was implemented in the mid-1990s. The online system will be installed no later than June 2006.

The decision to discontinue the program followed a 2002 study by Abt Associates, Inc. (2002) that compared Ohio's program with the findings of the three most recent EBT system evaluations. These included the online system in the state of Maryland; the offline pilot in Dayton, Ohio, on which the Direction Card system was later built; and the offline system in the state of Wyoming. The study found Direction Card was more expensive than Maryland's online system, but less expensive than the offline systems in Dayton, Ohio, and Wyoming. Abt Associates estimated that the total operational costs of the Direction Card system were 56 percent higher than Maryland's system due to more expensive hardware, software, and local agency costs. The Direction Card was 29 percent less expensive than the Dayton pilot because of the larger scale of the Direction Card program, the lower costs of building the Direction Card system upon the Dayton pilot, and the decreased technology costs resulting from technological developments that emerged after the Dayton pilot was deployed. The Direction Card

was 43 percent less expensive than Wyoming's program due to lower local, state, customer service, data center hardware, software, POS, and card costs (Abt Associates, Inc., 2002).[8]

The Abt Associates study also reviewed advantages and disadvantages of the Direction Card from the perspective of retailers. Ohio's merchants received free terminal installation, initial user training, and maintenance; however, they never found a cost-effective way to integrate the offline system into their existing online POS devices. Therefore, Ohio retailers bore the ongoing costs of training staff to use the separate terminal, not to mention lost counter space. There were also differences in costs related to equipping store lanes with EBT POS devices. Even though the number of POS devices given to large retailers by Ohio was more generous than the FNS mandated, large retailers did not have enough terminals to equip every checkout lane in the store. To do so, they would have to pay for extra POS devices. In contrast, online merchants that integrated EBT transactions into existing POS devices could service EBT customers in any lane. However, most online systems did not pay the costs of integrating cards into existing POS devices, which then shifted the costs of doing so to the merchant. Those online merchants that did not integrate EBT transactions into existing POS devices either used the state's allotment of EBT terminals or paid for extra equipment, but online terminals were less expensive than offline terminals (Abt Associates, Inc., 2002).

The Abt Associates study also compared the experiences of Ohio's EBT cardholders with those of EBT recipients accessing online systems. While Ohio recipients had higher levels of service due to hands-on training at Direction Card system offices, this specialized training also required extra time from the cardholder and sometimes necessitated an added trip to the local office. In contrast, states with online systems piggybacked on the widespread use of magnetic stripe cards for other applications, as well as typically providing cards, training materials, and personal identification numbers (PINs) by mail. There were also differences in loading value onto the card. Ohio EBT recipients are required to load their benefits at any one of three stores of their choosing or at their local food stamp office. In contrast, EBT recipients with magnetic stripe cards do not have to load value on the card at any specific location because value is stored on the central computer server (Abt Associates, Inc., 2002).

In addition, EBT smart card recipients may have experienced more confusion about the current value on their cards. Almost 90 percent of the Direction Card calls to customer service centers were to check the card balance. Similarly, the majority of customer service calls for online systems were to check account balances. The report indicates, however, that there may be an additional reason for balance inquiry calls for offline cards. The Direction Card system deducts the purchase amount from the chip on the card at the time of purchase. Information about the transaction is sent to the central computer server via batch processing at the end of the day when the beneficiary's account information is updated. In contrast, online systems verify transactions real-time against the central computer server, and balances are updated immediately. Thus, offline card users may have been confused by the balance information on the audio response unit, which obtains information from the central computer server on a lag basis, compared with their knowledge of the available balance based on known card transactions and expected benefits (Abt Associates, Inc., 2002).

The Abt Associates report also considered the transferability and adaptability of Ohio's Direction Card to food stamp programs in other states. The main obstacle cited was the need to build a system from scratch, since few retailers have POS devices capable of reading smart cards because consumer demand for these cards has not reached a critical mass. Moreover, EBT recipients outside Wyoming and Ohio benefit from the interoperability of online systems, allowing them to access benefits in 48 states. Ohio and Wyoming recipients can only use smart cards in their own respective states, unless an out-of-state store is specially equipped to accept them.[9]

Campus smart cards

Numerous e-purse programs have been implemented in closed-loop college and university environments for a variety of reasons: Students are open to new technologies; universities are able to implement more secure IDs that are not as easily duplicated as magnetic stripe cards; and schools are able to reduce administrative costs and to generate transaction fee income. Despite these benefits, most campus smart card trials have failed. In *University Business* magazine, Villano (2004) reports that of the approximately 50 schools in the United States that implemented smart card programs from 1997 to 2002, only a handful are still using them and relatively few take full advantage of the capabilities the technology provides. Failures are attributed to the high costs of offline systems compared with those of online systems, lack of interoperability, and delays in batch processing that mean card balances may not be updated for up to 24 hours.

University of Michigan

One of the largest e-purse deployments at a campus in the United States began at the University of Michigan in 1995 in response to students' and merchants' requests that the school's Entrée Plus system be extended off campus (Mayer, 1996). Entrée Plus was a funds pool into which parents put money at the beginning of the year for meals at residence halls and snack bars, as well as for on-campus purchases at vending machines, bookstores, and laundry facilities (Mitchell, 1998). As it turned out, it was not feasible to expand the Entrée Plus system off campus, so the university developed a proprietary offline POS network called the Mcard (Mayer, 1996).

In June 2001, the university announced that smart cards would be gradually discontinued and replaced with magnetic stripe cards (Avisian, Inc., 2002). A number of factors influenced the failure of the offline system, including technology problems; the overall cost relative to online systems; the lack of a critical mass of users and merchants; confusion related to concurrent programs on the card;[10] and the apparent lack of a business case at the outset.

Factors influencing failure

In terms of technical problems, outdoor card readers did not function well in cold weather, and transaction times took longer than cash (Mitchell and O'Brien, 1999). In addition, the chip on the Mcard malfunctioned nearly one-quarter of the time when it was first implemented (Doyle, 2005). Some cashiers had not been properly trained, which resulted in delays, and students became frustrated and eventually mistrustful of the card (Michigan Daily, 1996).

Over time, the school found that the Mcard was more useful as a coin substitute than as a paper currency replacement. As such, the school required technology that would support pay phone, parking meter, and central parking facility transactions, but these were beyond the capability of the system (Doyle, 2005). Faced with an obsolete technology, the university sought bids from Visa, Mondex, and Proton to update the program. However, costs were considered too high, and the school announced it would revert to an online system (Kuykendall, 2001).

Moreover, usage of the Mcard was lower than expected. Over a year after its implementation, transaction volumes were 20 percent less than anticipated and dollar values 30 percent to 35 percent below target (Chakravorty, 1996). Although usage rates would generally be lower at the beginning of any new payment technology, the Mcard illustrates a classic dilemma: Cardholders wanted more merchants to accept the card, while merchants wanted more cardholders to use it.

It was also hoped that the Mcard program would provide students and staff with a convenient payment tool that would generate revenues for the school. The Mcard included a microchip for payments, a bar code for checking out library books, and a magnetic stripe that functioned as a debit card as well as provided building access. Phone card functionality was also included on the card (Mitchell, 1998). The University of Michigan received part of the ATM transaction fees and calling card revenues in addition to 50 percent of the merchant transaction fees paid to the school's bank, First of America (Doyle, 2005). However, students and parents were confused by the many concurrent programs that operated separately on the card. In addition, students preferred the Entrée Plus program to the e-purse program. With Entrée Plus, parents could deposit funds to a university account that students could draw from to make on-campus purchases, whereas with the e-purse, students typically used their own money to load value onto the chip (Mitchell and O'Brien, 1999).

Moreover, the on-campus rollout of the Mcard was not well coordinated, and merchant fees were viewed as high. Only one of the campus's 22 libraries accepted the card for photocopies because most had already implemented their own copy systems prior to Mcard's launch (Doyle, 2005). Some other campus locations did not accept the Mcard, and the number of purchases with the Mcard was lower than with credit cards. On-campus merchants initially paid fees of 4 percent for transactions on the chip and BankStripe (a closed-loop debit card linked to a First of America checking account), which were later lowered to 2.8 percent, while off-campus merchants consistently paid 4 percent (Doyle, 2005). Merchant interest in the program was also low due to the high cost of the card reader, $900, resulting from the lack of competition from other vendors (Gale Group, Inc., 1998).[11]

Finally, it is unclear whether a business case for smart card over magnetic stripe technology was fully developed. The Mcard program was originally piloted as a magnetic-stripe ID card. When the supplier that provided the cards and readers was purchased by a leading smart card vendor a few months after the pilot began, the university's bank suggested that a microchip be added to the magnetic stripe card to facilitate faster on- and off-campus payments and to provide students with a cash substitute for pizza deliveries to dorms and for meals in restaurants (Mitchell, 1998).

University of Central Florida

Another campus card program was implemented in 1998 at the University of Central Florida (UCF) and remains in operation. The UCF Card is a required student ID and includes a magnetic stripe for debit card transactions and a computer chip with three separate e-purses. Cardholders must have an account with SunTrust, the issuing bank, to use the debit card functionality.[12] The main reason the program was implemented was to complement the university's image as a cutting-edge technology school. Three factors appear to be influencing the current success of the UCF Card: in-house processing, the requirement for the card to be used in the computer lab, and merchant and student interest in expanding the program off campus.

Factors influencing success

Tamara Kidder (2005), the UCF Card manager, reports that the university now performs its own transaction processing, which is quicker than the processing offered by their initial vendor. Moreover, the number of students and staff using the UCF Card increased from 20 percent in 2003 to 50 percent in the summer of 2004 as a result of the computer lab requiring the card for print copies. Students also enjoy the security of two PIN-protected e-purses; if the UCF Card is lost or stolen, these funds can be transferred to a new card.

Similar to the evolution of the Octopus card, the expansion of the UCF Card off campus was driven by both student and merchant demand. Currently, the card is used to purchase on-campus pizza deliveries and off-campus meals at six fast food and other restaurants. Twenty additional merchants are interested in joining the program (Kidder, 2005), which suggests that the 3 percent merchant discount fee is not viewed as a barrier.

Military smart cards

One other sector where e-purse applications have been developed and implemented successfully in the United States, albeit in a fairly narrow range of cash management applications, is the U.S. government. Since the inception of its stored-value card (SVC) program in 1997, the U.S. Department of the Treasury has issued more than 1.4 million smart cards that support specific business processes within each branch of the U.S. Armed Forces (Mackenzie, 2004).[13] The program aims to end the float loss associated with the more than $2 billion in coin and currency in circulation on military bases, ships, and other locations worldwide—and the associated cost of securing, transporting, and accounting for cash held outside the Treasury. The cards also eliminate the manually intensive back-end operations necessary to support scrip, vouchers, meal tickets, money orders, traveler's checks, and other paper payment mechanisms used in closed government environments. Two types of SVC cards currently in use are Navy Cash™ and EagleCash.[14]

Navy Cash™ card

Navy Cash™ reduces the cash handling and fiduciary costs associated with safeguarding and storing large amounts of paper currency and coins on board ships by combining two technologies on the same card: smart card chip and magnetic stripe. The e-purse on the chip is used for onboard purchases, and the magnetic stripe is used for purchases during shore leave. On a recent voyage of the USS Harry S. Truman, which has a crew of 5,000, there were over US$1 million in sales using the Navy Cash™ card (Gosnell, 2004). As of September 30, 2005, 66 ships have been deployed with Navy Cash™, and a total of 160 are scheduled to convert to the system by 2008 (Straw, 2005a).

Factors influencing success

A number of factors are influencing the current success of the Navy Cash™ program, including cost savings for the Navy, high customer satisfaction among crew members, and powerful incentives that drive critical mass.

Navy Cash™ reduces labor-intensive cash handling as well as lowers fiduciary and reporting costs by decreasing the need for paper currency and coins on board ships by 50 percent to 60 percent. In addition, a "cashless" shipboard environment allows more time for crew members to focus on core mission functions. Navy Cash™ also provides crew members with greater services and security, and supports access to home bank and credit union accounts. The Navy Cash™ system has been taken successfully around the world with a high rate of customer satisfaction (Straw, 2005b).

The Navy is very motivated to cut costs, and provides cards free of charge to crew members. While adoption of the program by servicemen and servicewomen is voluntary, those crew members who choose to forgo the card cannot make onboard purchases at retail POS terminals or at vending machines. Instead, they only receive standard food and supplies issued by the Navy, as no cash is accepted on the ship (Rivers, 2004).

EagleCash

A second military stored-value smart card called EagleCash began in 1999. It is used by U.S. Army and civilian workers in parts of the world with weak telecommunications and banking infrastructures. Personnel use the reloadable card on bases to purchase goods and services as well as foreign currency. First

deployed in Bosnia, the EagleCash smart card is also used in Afghanistan, Honduras, Kosovo, Macedonia, Qatar, and Uzbekistan. Future deployments may include military bases in Iraq, Kuwait, Saudi Arabia, and the Sinai (De Jesus, 2005).

Factors influencing success

The current success of the EagleCash program can be attributed to a number of factors. Staff is able to pay for goods in countries where banking and telecommunications infrastructures are weak and benefit from faster checkout lines at on-base POS terminals, where checkout times decreased by an average of 45 seconds (Federal Document Clearing House, Inc., 2000). The military benefits from a reduction in U.S. currency in hostile areas, which could potentially be used to fund terrorism due to the stronger market value of the U.S. dollar in these regions (Thompson, 2004). The risk of counterfeiting and black marketing is also diminished. In the Balkans, EagleCash lowered U.S. currency in circulation by $160 million (De Jesus, 2005).

Implications for future e-purse programs

A review of six e-purse programs in Hong Kong and the United States reveals that the successful programs operate in captive markets and sometimes require use of the card to establish a critical mass of users as seen in the Direction Card, Navy Cash™, UCF Card, and Octopus programs. For example, the Direction Card program required EBT recipients to migrate from paper food stamps to smart cards. Navy Cash™ is almost mandatory, since service personnel are unable to make onboard purchases without the card. University of Central Florida students are required to use the UCF Card in the school's computer lab, and this requirement resulted in an increase in the number of students and staff using the card from 20 percent to 50 percent. Octopus leveraged the transportation industry in Hong Kong, where over 70 percent of its commuters take public transportation every day. Commuters who travel via rail and metro can only purchase multiple ride tickets using the Octopus card. Of course, required use of smart cards is possible in closed-loop environments; however, mandatory usage of smart cards has little chance of successful implementation in open-loop environments where consumers are accustomed to payment choices.

Octopus's initial focus on the transportation sector also supports Van Hove's (2004) observation that successful smart card programs typically receive support from key players in at least one of the following: public transportation, public telephones, parking meters, or vending machines. Public transportation proved to be the conduit for establishing critical mass in Hong Kong. Is such a system feasible in the United States? Greg Garback (2005), executive officer of the Finance Department of the Washington Metropolitan Area Transit Authority, indicates that U.S. transportation companies are investing $1 billion to improve their payment infrastructures through the use of contactless smart card technology. Cities with multimodal public transportation (trains, buses, subways, or ferries) like Chicago, Seattle, San Diego, Los Angeles, Boston, Houston, Atlanta, and San Francisco have installed contactless smart card systems. These regional transportation systems may one day lead to a single transit card that can be used in multiple cities.

The Netherlands is currently installing such a cross-country transportation system, which should be completed by 2006 (ASK, 2004). Octopus is providing back office support and operational expertise on the project (Tai, 2005). However, compared with the United States, both the Netherlands and Hong Kong are extremely small geographic areas, which certainly facilitate the implementation of a systemwide or countrywide e-purse strategy, as Van Hove (2004) observes. Furthermore, Hong Kong residents use public transportation daily. By comparison, the U.S. Census Bureau (2004) reports that there is only one U.S. city where the majority of the population (55 percent) takes public transportation—New York City. Other cities with a population of 250,000 or more have a smaller percentage of the population that takes public transportation each day.

Because the vast majority of commuters in the United States as a whole (77 percent) drive to work alone, some payment analysts argue that the RFID technology currently used in tollway systems in some metropolitan areas may be expanded to the retail sector in the future.[15] In fact, the E-ZPass system used by commuters in the northeastern United States conducted such a trial at two McDonald's drive-thru windows on Long Island, NY. In the *American Banker*, Wade (2004) reported, however, that the co-owner of these fast food restaurants had no plans to accept E-ZPass at the four other McDonald's he owned; that he was more excited about the possibility of accepting credit cards because they are more ubiquitous; that the E-ZPass system was more complicated to set up; and that it would be an uphill challenge to reach broad-based adoption. Part of the difficulty relates to the technology. The transponder that drivers use to store value and record tolls is about the size of a deck of cards, which makes it practical for tolls and drive-thru restaurants but not for a typical retail environment. Moreover, a widespread number of merchants would

have to bear the cost of installing smart card readers and a critical mass of consumers would have to prefer the device over other payment alternatives to make it successful.

While we have seen that some programs require smart card usage, this strategy does not guarantee success. The Ohio Direction Card program, which required EBT recipients to access benefits through the Direction Card, had the highest average daily transaction values of the six e-purse programs surveyed, well above the one million users that Goldfinger (1998) estimated would be necessary to offset infrastructure costs. However, Ohio's EBT system failed on account of the higher cost of the offline infrastructure relative to online systems. The Mcard program failed for the same reason. Therefore, a second key factor in a successful smart card program is overall cost compared with other payment alternatives. As such, the Navy Cash™, EagleCash, and UCF Card programs should be monitored over time. If the overall costs of these programs are higher than other payment technologies, their long-term success may be in jeopardy. This concern may be mitigated to some extent for Navy Cash™ because of the security that the card provides for ship check in.

A third key ingredient for a successful e-purse program is compelling incentives for consumers to use and for merchants to accept the new payment device frequently. In terms of Chakravorti's (2004) framework, Octopus offers consumers and merchants simultaneous benefits that are not provided by existing payment systems. For consumers, Octopus completes transactions faster than cash, provides an automatic reload feature, offers loyalty programs, and is the only e-purse surveyed that allows the purchase of goods up to a negative value. Merchants that accept the Octopus card benefit from quicker transaction times and ad hoc loyalty programs, as well as lower fees compared with those for credit cards. Nevertheless, a handful of retailers have found that the merchant transaction fees are too high and have withdrawn from the program.

When analysts predicted the success of e-purses during the 1990s, the main benefit envisioned was a cash substitute for small-value purchases. Octopus concentrates on the micropayments environment and provides merchants with reduced cash handling costs. However, Van Hove (2001) argues that merchants experience increased costs in the short term by supporting two separate infrastructures until a critical mass of e-purse users is established. The Navy Cash™ program was successful in substituting cash entirely for crew members on board ships, resulting in significant cost savings. Despite the University of Michigan's desire to replace coin-intensive transactions like those for pay phones, parking meters, and parking facilities, Mcard's technology was unable to support these devices.

In the United States, credit cards rather than e-purses may fill the micropayments gap. For example, some parking meters in Chicago accept credit cards, and the credit card industry plans to continue introducing contactless cards to speed payment. JPMorgan Chase & Co., the largest credit card issuer in the United States, has announced that it will issue millions of new contactless credit cards. American Express Co. plans to issue its contactless card, ExpressPay, to new customers in June 2006. More importantly, Visa, MasterCard, and American Express have agreed to a standard that enables properly equipped POS readers to accept contactless credit cards (Sidel, 2005). The success of contactless credit cards in filling the micropayments gap relies on two factors: a critical mass of consumers that are able to find enough chip reading terminals to use these cards frequently and a widespread number of retailers that view fees for small-value transactions on these cards affordable.

The final critical ingredient for a successful smart card program is technology that is well tested and addresses standards issues before rollout. As seen in the Mcard program (see appendix), technological difficulties decreased the adoption rate and contributed to the overall failure of the program.[16] In contrast, Octopus had very few problems in the initial rollout, and after 7-Eleven's implementation in the retail sector, Hong Kong's consumers pressed other merchants to accept the card as well. The UCF Card program reflects a similar desire from merchants and users to expand card usage; however, the UCF Card program is the only one with multiple e-purses and requires merchants to select the correct e-purse from which to deduct a transaction. A more streamlined technology that includes a single e-purse may increase adoption, but at the same time, a single e-purse may negatively affect parents' sense of control over funds being spent for school-related purposes.

Octopus also established interoperability between the various transportation providers before the program was launched, which smoothed its expansion into the retail sector. Still, Octopus may face interoperability issues in the future as Asia migrates to Europay/MasterCard/Visa (EMV) compliant credit cards. EMV facilitates the introduction of chip technology into the international payment systems by developing joint specifications for issuance, acceptance, and interoperability of chip-based debit and credit card transactions. An *ePaynews.com* article (Trintech Group Plc,

2004) reports that the Chinese banking industry is scheduled to complete a Chinese version of the EMV standard prior to issuing EMV chip cards.

It is difficult to anticipate what impact the EMV initiative might have on Octopus. One possibility is that merchants may be reluctant to have two separate smart card readers—one for Octopus cards and one for EMV credit and debit cards. Instead, they may want the computer chips on Octopus cards to be EMV compliant and POS terminals for the Octopus card and for EMV credit and debit cards to be integrated. This option will likely result in additional costs related to issuing new cards and to integrating existing card readers for both Octopus Cards Ltd. and its merchants. Some of these costs will likely be passed on to consumers. Another possibility is that the relatively low cost of Octopus transactions for merchants may offset the expense of maintaining dual infrastructures.

Military cards may also face interoperability and cost issues because of some new initiatives in the United States, such as the Government Smart Card (GSC) initiative and Homeland Security Presidential Directive (HSPD) 12. GSC is designed to adopt smart card technology for every federal employee for a wide range of purposes, such as building access. HSPD 12 establishes government-wide standards for secure and reliable forms of identification issued by the federal government to its employees and contractors (White House, Office of the Press Secretary, 2004). Open standards on how to build a smart card infrastructure across all federal agencies are being published, and presumably, military cards will need to conform to these standards.

Conclusion

Of the six e-purse programs reviewed, Octopus and Navy Cash™ have come closest to creating the cashless world foretold by many analysts in the 1990s. While the Navy Cash™ program entirely replaces cash on board ships equipped with the system, the scale of the program is far smaller than that of Octopus, which used the transportation industry to achieve critical mass. The Octopus model may be difficult to replicate here because the U.S. population is much larger, is more geographically dispersed, and does not rely as heavily on public transportation. In addition, the United States is a less cash-intensive society compared with Hong Kong, where an e-purse for small-value transactions may have more utility. The United States also has an efficient, advanced, and inexpensive telecommunications infrastructure for debit, credit, payroll, and gift cards that has relatively low levels of fraud.

One way to establish critical mass is to require use of smart cards over other payment alternatives, as seen in the Direction Card program in Ohio. However, even if usage is mandatory, the overall cost of a smart card system relative to other payment options is critically important to its success. Required usage is also impractical in an open-loop environment where consumers are accustomed to payment choices.

Successful e-purse programs also provide consumers and merchants with powerful incentives to use and accept the card. Octopus has been highly successful in this regard; still, a handful of merchants have found the fees too high and defected from the program.

Finally, technology that is well tested and addresses standards issues before rollout is another factor in a successful e-purse program. Inferior technology helped doom the Mcard program, while Octopus provides a highly interoperable system with a low error rate.

APPENDIX: E-PURSE PROGRAMS

E-purse	Octopus card	Direction Card	Mcard
Status	Successful	Failed	Failed
Cards issued	12,700,000	3,203,066	92,000
Average usage per transaction	$1.00	$29.50	$0.43
Average daily transaction value	$1,411,000[a]	$2,765,102[b]	n.a.
Locations accepting card	Over 50,000	5,123	342
Reader	Contactless	Contact	Contact
How it works	Choice of three cards: On-Loan Anonymous costs HK$150 ($19) and includes a HK$50 deposit and a HK$100 stored value amount; Sold Octopus costs HK$70 and has no stored value; and Personalized Octopus costs HK$100 and includes a HK$50 deposit, a HK$20 printing and handling charge, and a stored value amount of HK$30. Consumer can automatically reload personalized cards through credit card or bank account, and most banks and credit card issuing companies offer bonus points or cash rebate for automatic reload feature. Consumer can reload all three cards with cash.	Ohio EBT recipients receive cards for free and are required to load their benefits at any three stores of their choosing or at the local food stamp office.	Card was required ID on campus and included microchip for payments, bar code for checking out library books, and magnetic stripe for building access. The magnetic stripe also functioned as a closed-loop debit card, called BankStripe, linked to a First of America checking account. Card also had calling card capabilities. Value could be added to the e-purse at 23 CashChip machines on campus.
Maximum stored value	HK$1,000 ($128)	n.a.	$50
Merchant incentives	Reduced cash handling, quicker transaction times, marketing information, lower fees than credit cards.	Free terminal installation, training, maintenance. No transaction costs.	Lowered cost of terminal and merchant discount fees from 4 percent to 2.8 percent.
Consumer incentives	Speed, convenience, purchases up to negative value, security, loyalty discounts.	High levels of customer service, standardized procedures.	Coupons, free transfers from checking to chip, discounts when used instead of cash.
Other factors related to success or failure	Cooperation of major transportation companies, leverage of transportation industry to establish critical mass, reliable and interoperable technology.	Overall costs, interoperability.	Malfunctioning technology, long transaction times, poor training, low merchant discounts, costly readers.
Adoption	Voluntary	Mandatory	Voluntary
Other payment instruments accepted at point of sale	Primarily cash, but credit cards, debit cards, checks at some locations.	Cash, checks, credit cards, debit cards.	Cash, checks, credit cards, debit cards.

APPENDIX: E-PURSE PROGRAMS (CONTINUED)

E-purse	UCF Card	Navy Cash™	EagleCash
Status	Successful	Successful	Successful
Cards issued	120,000	68,883[c]	56,659
Average usage per transaction	$3.98	n.a.	n.a.
Average daily transaction value	$6,691	$25,000	$15,000
Locations accepting card	359	892,000 ATMs and 32 million merchants worldwide.	n.a.
Reader	Contact	Contact	Contact
How it works	Students and parents add value through the WebRevalue online service, fax, mail, or phone. Students and parents can also visit the UCF Card Services office and provide cash, check, debit cards, or credit cards. Students and parents can load money to the first e-purse by using Cash-to-Chip machines on campus. Transfers among e-purses require a visit to the UCF Card Services office.	Onboard purchases and chapel donations are made through the chip. Purchases ashore, over the phone, or on the Internet are made though the magnetic stripe at any location accepting MasterCard. Onboard cashless ATMs can be accessed to check balances; move money from stripe to chip and vice versa; access bank or credit union accounts to transfer money; complete a ship "check in" when reporting aboard for permanent or temporary duty; and transfer money from one crew member's account to another.	Value added through payroll deposits, bank account transfers, and checks. Departing staff turn in card, and any remaining amount is refunded in cash. Cards have an expiration date, so staff who forget to turn in their card have the remaining balance deposited directly to their bank accounts.
Maximum stored value	E-purse 1: $100, for on-campus purchases at vending machines, photocopiers, laundries, and printing facilities. E-purse 2: $5,000, for tuition and on-campus purchases at the book store; PIN protected. E-purse 3: $5,000, for retail purchases on and off campus; PIN protected.	$1,000; PIN protected, although purchases under $25 from vending machines do not require PIN.	$9,999.00
Merchant incentives	Access to nearby student population.	None	None

APPENDIX: E-PURSE PROGRAMS (CONTINUED)

E-purse	UCF Card	Navy Cash™	EagleCash
Consumer incentives	Security, discount at vending and copy machines, off-campus restaurant options.	Free card, no transaction fees, greater security, access to home bank accounts.	Free card, payment instrument for use in hostile territories with weak banking and telecommunications infrastructures, speed, security.
Other factors related to success or failure	Gives parents some control over funds being spent for school-related purchases.	Reduces cash handling, fiduciary, and reporting costs.	Decreases costs of transporting and safekeeping currency and reduces the risk of U.S. currency falling into the hands of terrorists.
Adoption	Mandatory for computer lab; voluntary for other uses.	Voluntary	Voluntary
Other payment instruments accepted at point of sale	Some locations cash only; some locations cash, checks, credit cards, debit cards.	None for crew members; visitors may be allowed to use cash and checks.	Cash, checks, credit cards, debit cards.[d]

[a]$8,300,000 average daily transactions multiplied by 0.17 (percent of retail transactions).
[b]2004 Ohio food stamp benefits divided by 365, based on information from the U.S. Department of Agriculture, Food and Nutrition Service (2005).
[c]Number of cards issued and average daily transaction value for Navy Cash™ and EagleCash provided by the U.S. Department of the Treasury.
[d]The U.S. Army Finance Command has issued a communication that EagleCash is the standard in the field, but the decision to accept other payment instruments at the point of sale rests with local command.
Notes: Amounts in U.S. dollars, unless stated otherwise. n.a. means not available.

NOTES

[1]Smart cards are credit-card-sized plastic cards embedded with a microchip that are more difficult to counterfeit and can store more information than magnetic stripe cards.

[2]The geographic concentration of the potential users of an e-purse is also important. For example, it would be cheaper to support one million smart card users in a concentrated market like Hong Kong versus one million smart card users in the whole of China.

[3]Hong Kong has had a stable exchange rate of HK$7.8 to US$1 since the mid-1980s; its GDP was US$158 billion in 2003.

[4]For a detailed discussion of the New York City trial, see Van Hove (2001).

[5]While some retailers and credit card companies, such as Target Corporation and American Express, have added computer chips that do not have stored-value capabilities to their cards, their customer programs have either failed or have not established a critical mass of users.

[6]For a discussion of the open-loop Mondex trial in Hong Kong, see Westland et al. (1998). Electronic Transaction Association (2001) discusses the Atlanta Olympics e-purse trial. Again, for a detailed discussion of the New York City trial, see Van Hove (2001).

[7]Total Octopus transactions in 1998 are unavailable. Using current statistics of 8.3 million daily Octopus transactions, this would represent a failure rate of 0.01 percent.

[8]There have been no announcements of Wyoming's intention to discontinue its smart card program, which is used to administer the EBT program and the Women, Infants, and Children (WIC) program. An industry source indicates that if an online WIC program pilot by the state of Washington proves to be a success and a good business strategy, then Wyoming will be open to the best business case when it rebids its EBT services.

[9]Out-of-state stores accepting smart cards are generally located near Ohio's and Wyoming's state borders.

[10]The Mcard's concurrent programs included Entrée Plus, BankStripe, a calling card program, and a chip program. Entrée Plus transactions were deducted from the school's pre-established funds pool. BankStripe transactions were deducted from the cardholder's First of America checking account. Calling card transactions were billed in one of two ways—on the student's phone bill or on a prepaid basis through Ameritech. Chip transactions were deducted from the stored value on the card (Doyle, 2005).

[11]Enhancements to the Mcard were offered late in the program, but failed to have a positive effect on usage. These included migrating to an open debit card network, offering free funds transfers from First of America checking accounts to the chip, providing visitors with loaded Mcards for meals and other sundries, promoting merchants in monthly newsletters, and reducing the cost of terminals. Other incentives included distributing coupons from participating merchants to students paying with the Mcard, offering students who watched a training video about the card $5 on the chip, and providing vending machine and merchant discounts when the card was used instead of cash (Doyle, 2005).

[12]Unless indicated otherwise, information on the UCF Card is from the University of Central Florida (2005).

[13]Additional information was taken from the U.S. Department of the Treasury, Financial Management Service (2005).

[14]A third program, EZpay, provides all U.S. Army, U.S. Air Force, and U.S. Marine basic trainees with a disposable EZpay card with a fixed amount of electronic currency for purchases at base stores, beauty and barber shops, cleaners, gift shops, museums, phone centers, photo stores, and video stores. The amount loaded on the card is deducted from the trainee's first paycheck (Mackenzie, 2004).

[15]After paying for tolls in advance, drivers are issued a transponder about the size of a deck of cards that is mounted on the windshield and allows them to pass through a tollbooth without stopping the vehicle. The card can be linked to a consumer's debit or credit card to automatically replenish funds.

[16]Malfunctioning technology also impeded card adoption in the Mondex and Visa Cash trial in New York City.

REFERENCES

Abt Associates, Inc., 2002, *Evaluation of the Expanded Off-line EBT System in Ohio, Vol. 2: Assessment of Statewide Operations*, report to U.S. Department of Agriculture, May.

ASK, 2004, "ASK contactless cards & tickets selected for the Netherlands whole AFC system," PRNewswire, July 30.

Avisian, Inc., 2002, "Out with the new, in with the old at Michigan," *SecureIDNews*, January 14, available at www.secureidnews.com, accessed on November 19, 2004.

Balaban, Dan, 2005, "Road to retail transactions is a long one for transit card operators," *CardTechnology*, March 1.

Bank for International Settlements, Committee on Payment and Settlement Systems, 2003, "Payment and settlement systems in selected countries," Basel, Switzerland, April.

BusinessWorld Publishing Corporation, 2002, "Hong Kong embraces the Octopus Card," *BusinessWorld Online*, June 6.

Chakravorti, Sujit, 2004, "Why has stored-value not caught on?," *Journal of Financial Transformation*, Vol. 12, December.

Chakravorty, Prachish, 1996, "After 1 year, M-card not meeting goals," *Michigan Daily Online*, September 20, available at www.pub.umich.edu/daily/1996/sep/09-20-96/news/news8.html.

Cheng, Cindy, 2004, interview with sales and marketing director, Octopus Cards Ltd., by Carol L. Clark, May 12.

De Jesus, Juan A., 2005, interview with senior financial analyst, U.S. Army Finance Command, by Carol L. Clark, April 6.

Dove Consulting, 2003, "How U.S. consumers made in-store payments, 1999–2003," table, December, available at www.epaynews.com/newsletter/epaynews245.html, accessed on August 9, 2004.

Doyle, David, 2005, interview with marketing and sales coordinator, Mcard Administration, Treasurer's Office, University of Michigan–Ann Arbor, by Carol L. Clark, February 15.

Electronic Transaction Association, 2001, "An industry primer on smart cards," white paper, October, available at www.sctn.com, accessed on August 6, 2004.

Euromonitor International, 2004, "Financial cards in Hong Kong, China," report, London, May.

Federal Document Clearing House, Inc., 2000, "Army adopts EZpay for trainees, tests Eagle Cash in Bosnia," press release, Washington, DC, August 17.

Gale Group, Inc., 1998, "Terminal obstacle," *CardFAX*, Vol. 1998, No. 212, October 15.

Garback, Greg, 2005, interview with executive officer, finance department, Washington Metropolitan Area Transit Authority, by Carol L. Clark, January 21.

Goldfinger, Charles, 1998, "Economics of financial applications of the smart card: A summary overview," available at www.fininter.net/Archives/fasc.htm, accessed on June 1, 2004.

Gosnell, David, 2004, "Anchors aweigh for debit: The U.S. Navy is bringing a smart card-based payment system to ships and plans to mothball ATMs," *Credit Card Management*, Vol. 17, No. 6, September 1.

Kidder, Tamara, 2005, interview with UCF card program manager by Carol L. Clark, March 2.

Kuykendall, Lavonne, 2001, "Chip card dropouts: Universities of Mich., Ill.," *American Banker*, Vol. 166, No. 181, September 20.

Mackenzie, Graham, 2004, interview with smart card program manager, U.S. Department of the Treasury, by Carol L. Clark, October.

Mayer, Mary, 1996, "Mcard is largest smart-card program in U.S.," *Information Technology Digest*, Vol. 5, No. 1, January 8.

Michigan Daily, 1996, "M-card malaise: 'U' must review its pet financial project," *Michigan Daily Online*, Sept. 25, available at www.pub.umich.edu/daily/1996/sep/09-25-96/edit/edit2.html.

Mitchell, Richard, 1998, "Big Blue's big card ambitions," *Card Technology News*, November 19.

Mitchell, Richard, and Kerrie O'Brien, 1999, "Universities open their minds to smart cards," *Card Technology News,* March 12.

Morgan, Peter, and Audrey Snee, 1997, "Giving everybody credit: Marketing madness in Hong Kong's card war," *AsiaWeek.com,* August 29, available at www.asiaweek.com, accessed on March 7, 2005.

Poon, Simpson, and Patrick Y. K. Chau, 2001, "Octopus: The growing e-payment system in Hong Kong," *Electronic Markets,* Vol. 11, No. 2, May, pp. 97–106.

Ramstad, Evan, 2004, "Hong Kong transit operators find being cashless is king," *Asian Wall Street Journal,* February 19, p. A8.

Rebelo, Jorge M., 1999, "Automated ticketing systems: The state of the art and case studies," *LCSFP Knowledge Management Product,* Washington, DC: The World Bank, May, available at http://lnweb18.worldbank.org/External/lac/lac.nsf/Sectors/Transport/24063D35CEF58103852568B2007692FB?OpenDocument, accessed on June 2, 2004.

Rivers, Mary, 2004, interview with program manager, Navy Cash, Navy Cash, Naval Supply Systems Command Headquarters, by Carol L. Clark, October 27.

Rochet, Jean-Charles, and Jean Tirole, 2003, "An economic analysis of the determination of interchange fees in payment card systems," *Review of Network Economics,* Vol. 2, No. 2, June, pp. 69–79.

Scaggs, John, 2005, interview with state of Ohio EBT director by Carol L. Clark, January 20.

Sidel, Robin, 2005, "New way to pay by credit card: With a wave," *Wall Street Journal,* May 19, p. B1.

Straw, Barbara C., 2005a, interview with program director, Navy Cash, U.S. Navy, by Carol L. Clark, September 16.

_____, 2005b, interview with program director, Navy Cash, U.S. Navy, by Carol L. Clark, April 15.

Tai, Eric, 2005, interview with chief executive officer, Octopus Cards Ltd., by Carol L. Clark, January 31.

Thompson, Johnny A., 2004, "'Eagle Cash' provides safe, expedient way to pay," *Defend America,* March, available at www.defendamerica.mil/articles/mar2004/a030504b.html.

Trintech Group Plc, 2004, "China's banks advised to migrate to EMV cards," *ePaynews.com,* September 17.

_____, 2003, "Octopus card to extend to retail payment," *ePaynews.com,* January 30.

U.S. Census Bureau, 2004, "Nearly one-third of nation's public transportation commuters live in New York City," press release, Washington, DC, March 2.

U.S. Department of Agriculture, Food and Nutrition Service, 2005, "Food and Nutrition Service homepage," website, available at www.fns.usda.gov, accessed on September 3, 2005.

_____, 2004, "EBT fact sheet," report, available at www.fns.usda.gov, accessed on October 1, 2004.

U.S. Department of State, Bureau of East Asian and Pacific Affairs, 2004, "Background note: Hong Kong," report, available at www.state.gov, accessed on May 14, 2005.

U.S. Department of the Treasury, Financial Management Service, 2005, "Final Management Service homepage," website, available at www.fms.treas.gov, accessed on May 5, 2005.

University of Central Florida, 2005, "UCF card services," website, available at www.ucfcard.ucf.edu, accessed on February 28, 2005.

Uzureau, Christophe, 2003, "All change for e-cash as smart commuters ditch notes and coins," *GartnerG2,* report, May 27, available by subscription only at www.gartnerg2.com/rpt/rpt-0503-0041.asp.

Van Hove, Leo, 2004, "Electronic purses in Euroland: Why do penetration and usage rates differ?," *SUERF Studies,* Morten Balling (ed.), Vienna, Austria: Société Universitaire Européenne de Recherches Financières.

_____, 2001, "The New York City smart card trial in perspective: A research note," *International Journal of Electronic Commerce,* Vol. 5, No. 2, Winter, pp. 119–131.

Villano, Matt, 2004, "Campus cards: Too smart for their own good," *University Business*, March, available at www.universitybusiness.com/page.cfm?p=475.

Wade, Will, 2004**,** "EZPass tries where others have failed," *American Banker*, April 1.

Welsh-Huggins, Andrew, 2003, "Ohio to replace costly high-tech stamp system," *USA Today*, October 7.

Westland, J. C., M. Kwok, J. Shu, T. Kwok, and H. Ho, 1998, "Customer and merchant acceptance of electronic cash: Evidence from Mondex in Hong Kong," *International Journal of Electronic Commerce*, Vol. 2, No. 4, Summer, pp. 5–26.

White House, Office of the Press Secretary, 2004, "Homeland Security Presidential Directive/HSPD-12," press release, August 27.

Wong, Joey, 2005, interview with public relations manager, Octopus Cards Ltd., by Carol L. Clark, September 21.

Wynne, George, 1998, "Hong Kong is leading in contactless fare technology," *Passenger Transport*, February 16, p. 6.