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.

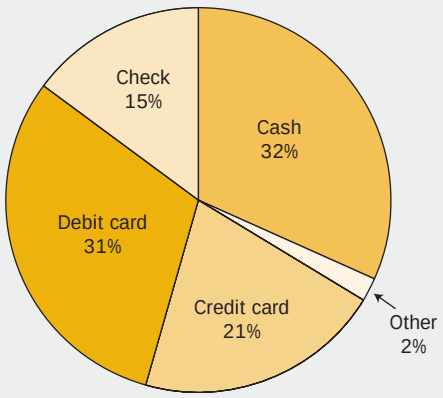
Payments environment in Hong Kong and the United States

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

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.