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Abstract

Most discussions and analyses regarding Japanese financial institutions during the 1990's have focused on the lingering effects of the collapse of the bubble economy, including huge non-performing loans and large-scale bank failures. Thus, it is natural for foreign observers to fail to acknowledge that many Japanese banks and other non-bank enterprises have conducted forward-looking projects despite their financial difficulties. One of these projects has been to develop digital cash technology and promote its usage. Because people in Japan tend to use cash for daily payments more often than people in other nations, if the Japanese begin using digital cash instead of traditional cash (i.e., Bank of Japan's notes and coins), we anticipate that digital cash will have a larger potential effect on the society and economy in Japan than in other nations. Efforts to establish digital cash projects made discernible progress in the early 2000's, and digital cash is more commonly used now in Japan than in other IT advanced countries. This paper attempts to provide an overview of the recent development of digital cash projects in Japan, and to discuss the issues involved in the further growth of digital cash usage. This paper is organized as follows. Section 1 presents the introduction. In Section 2, we explain the historical developments of digital cash projects in Japan. Section 3 discusses what factors led to remarkable progress in digital cash usage in the early 2000's. Section 4 describes the remaining issues that must be addressed for further growth of digital cash usage. Finally, Section 5 concludes the paper.

Keywords (1) Digital Cash, (2) Electronic Payment, (3) Settlement Systems, (4) Hybrid Smartcard, (5) Strategy and Policy, (6) Japan.

Recent Developments of Digital Cash Projects in Japan

1. Introduction

Foreign observers who know that Japan suffered prolonged financial difficulties and an economic slump in the 1990's may be surprised to find that the use of digital cash as a tool of payments or settlements has grown rapidly in Japan. In fact, an increasing number of people in Japan use digital cash for shopping. In addition, most Japanese people know the names used for digital cash, such as "Edy" or "Suica," even if they do not use digital cash themselves. The Japanese have become familiar with digital cash.

Only several years ago, financial economists thought that the diffusion of digital cash or electronic money would not easily occur¹. The reason was that there were many obstacles to the spread of digital cash. As we indicate in this paper, a significant number of those obstacles have been eliminated by the government and through the efforts of many private enterprises. The main purpose of this paper is to examine the factors affecting digital cash diffusion in Japan. For this purpose, we would like to examine the history of various digital cash projects in Japan during the past decade.

We would like to point out that many problems remain to be solved before further growth of the digital cash business in this country can occur. One of the characteristics of the digital cash business in Japan is that digital cash schemes are mainly managed by the private sector rather than the public sector, and issuers of digital cash are not limited to banks. In other words, non-financial firms can issue "cash" now. In relation to such circumstances, it is necessary to consider what restrictions or policies are needed to maintain a stable payment system.

This paper is organized as follows. Section 2 examines the history of digital cash projects in Japan during the past decade. Section 3 examines the factors for the spread of digital cash in Japan. Section 4 indicates the problems that must be solved for further growth and stability of the digital cash system in this country. Section 5 presents the conclusion.

2. History of digital cash projects in Japan

2.1. Start-up period (1995 ~ 1997)

(1) High potentiality of information technology

The three years from 1995 to 1997 can be considered the start-up period of electronic money or digital cash projects in Japan.

Remarkably, innovative technologies like multi-functional-type or remote-type IC-cards, which made digital cash businesses in Japan superior to that in other countries in the early 2000's had already been developed in Japan before 1995. It is well known among digital cash researchers that Tim Jones and Graham Higgins, who are the parents of "Mondex," the first smartcard-type digital cash, entrusted the development of the card system to Japanese enterprises such as Dai Nippon Printing, Hitachi, Matsushita Electric Industrial and Oki Electric Industry in 1991. These corporations had researched and been developing IC-card payment technologies since the mid-1980's. For example, Oki Electric Industry had been involved in developing the IC-card system "Apron Card" in Kyoto City since 1986, which became an actual usable card in April 1992, when Mondex was still under experimentation².

(2) Governmental initiative

However, it was governmental initiatives, beginning in 1995, that led nation-wide experimental activities in electronic payment and settlements in Japan. At the initiative of the Ministry of Finance (MOF), the Bank of Japan (BOJ), Fuji Bank³, Nippon Telegraph and Telephone (NTT) and Fujitsu Corporation organized a council for the introduction of digital cash in October 1995. The council discussed whether there would be a strong demand for digital cash in Japan, how they would be able to avoid forgeries and robberies, and how they would be able to prevent money laundering.

In 1996, many private Japanese banks launched their own digital cash projects. For example, in April 1996, Daiichi Kangyo Bank, Sakura Bank and Asahi Bank⁴ introduced the use of a Smartcard for digital cash in the Waterfront Area of Tokyo, as an experiment. Additionally, in October of the same year, the Ministry of Transport (predecessor of the Ministry of Land, Infrastructure and Transport) together with Tokyo-Mitsubishi Bank, Sumitomo Bank and Sanwa Bank took part in this

Waterfront Area experiment. The goal of the project was to develop an IC-card commuter ticket system that would allow passengers not only to pay for an override charge, but also to buy food and other consumer goods in and around train stations. This technology afterward provided a technological base for “Suica,” which is one of the most diffused and popularized types of digital cash in Japan. The other digital- cash-related projects that started in this period are summarized in Table 1.

As other private sector projects, in February 1996, the Hitachi group, using their experiences obtained in the United Kingdom, began to focus on developing their own digital cash technology in Japan. In competition with Hitachi, the Mitsubishi group decided to invest in the subsidiary of Mondex in Japan, which was established in June 1996 by the Industrial Bank of Japan, Sakura Bank, Asahi Bank, NTT and Hitachi.

Table 1: Early digital cash projects in Japan (~1997)

Year	Month	District	Content
1992	Apr	Kyoto City, Nishi-shindo –nishikikai shopping street	An IC-card system, “Apron Card,” was introduced for use along a local shopping street.
1995	Oct	Metropolis, Tokyo	Daiichi Kangyo Bank and NTT Data Communications jointly developed an ATM that could handle digital cash.
1996	Mar	Metropolis, Tokyo	Sakura Bank established a special section devoted to the development of digital cash technology.
	Apr	Water front Area, Tokyo	Daiichi Kangyo Bank, Sakura Bank and Asahi Bank began an experiment with the Smart-card type of digital cash.
	Jun	Ogaki City, Gifu pref.	An IC-card experiment was begun at a multimedia center “Soft-pier Japan”.
	Oct	Komagane City, Nagano pref.	An IC-card system, “Tsuretette Card” was introduced for use on a local shopping street.
	Nov	Ina City, Nagano Pref.	An IC-card system, “Iina-Chan Card” was introduced for use on a local shopping street.
	Dec	Shizuoka Pref.	Shizuoka Prefecture organized a society for the study of Electronic Commerce.
1997	Apr	Metropolis, Tokyo	Asahi Bank and Matsushita Electric Industrial introduced IC-card type digital cash on the campus of Waseda University in cooperation with the University Co-op.
	Jul	Mitaka City, Tokyo	An experiment of digital cash in the shopping street in front of JR Mitaka Station.
	Aug	Yamagata Pref.	Nippon Arcadia Network, the third sector of the Prefecture, started an experiment using digital cash and e-commerce.
		Aomori Pref.	Michinoku Bank took part in the Business of Mondex International.
	Sep	Fukuoka Pref.	An IC-card experiment in which Fujitsu took a leading part began.
	Oct	Kobe City	An IC-card experiment with multi-functions including prepaid, credit and online payments, was initiated.
	Nov	Kanto-Koshinetsu District	A new settlement system was established through the cooperation of fifty-nine universities in the Kanto-Koshinetsu District collaborating with NTT Data and several city banks.

(3) Collaborations with overseas firms

The most remarkable development in the period after the second half of 1996 was that many Japanese firms began collaborating with foreign firms to start digital cash projects. In August 1996, Japan Information Printing, whose main business was to print prepaid cards, collaborated with Switzerland's *Kaldak* to produce IC cards. Moreover, in December, Hitachi took an order for an in-bank settlement system from *Westpac Trust*, the largest bank in New Zealand⁵. In the first half of 1997, Sumitomo Credit Service collaborated with *Microsoft*, *Veriphon* and *GTE* to develop a new electronic settlement service system on the Internet, and this consortium of companies strove to be the first to commercialize such a system in Japan⁶. *GTE* also established a new company with Nomura Research Institute, NTT Mobile Communications and B.U.G.⁷, and they issued electronic certificates for Sumitomo Credit and JCB in April 1997. *Microsoft*, on the other hand, competing with *GTE*, suddenly announced its participation in the project with Sumitomo Credit, and it collaborated with JCB to develop a new settlement system. *Microsoft* intended to overcome its rival company, *Netscape Communications*, which had collaborated with *VISA International* and Toshiba Corporation on digital cash experiments.

(4) General public attitude during this period

In the early stage of electronic money projects and e-businesses in Japan, consumers seemed hesitant to use digital cash. According to a survey on the opinions of financial institutions' customers conducted in August 1996 by the Institute for Posts and Telecommunication Policy, 1/3 of respondents answered that they were worried about innovations in finance such as digital cash and home-banking. Only 2% of respondents used home-banking services. Forty-one percent of them did not anticipate using home-banking services in the future, while 13% showed interest in using the services. Also, an astonishing 69% believed that home-banking services were not necessary, and 54% also said that they were not interested in using digital cash.

Moreover, according to a questionnaire conducted by Nihon Keizai Shinbun in October 1996, 74% of respondents in the United States anticipated significantly greater use of digital cash during the next ten years, compared to only 36% of Japanese respondents.

These results suggest that Japanese consumers in the mid-1990's did not value the convenience offered by digital cash and were concerned about the security of information and payments transmitted through new electronic settlement systems. To promote the general acceptance of digital cash, legislative activities seemed necessary.

(5) Legislative activities

Policy makers had recognized that related laws and regulations should be reformed to correspond to new technologies. In May 1996, the MOF organized a committee to review the Prepaid Card Regulations, and asked another committee to review the Foreign Exchange and Foreign Trade Control Act, which allowed only authorized foreign exchange banks to deal with foreign exchange transactions. The MOF then began to prepare for the revision of these laws and regulations. Moreover, in the same month, the Center for Financial Industry Information System, which was an affiliated organization of the MOF, concluded in its research report on electronic settlement that digital cash should be made available to the general public as soon as possible.

In July 1996, the Financial Research Council and the Committee on Foreign Exchange and Other Transactions, which was an advisory body of the MOF, established the Joint Conference on Digital Cash and Electronic Settlement to examine how to diffuse digital cash. At the first meeting of the month, it began discussion on revising the Prepaid Card Regulations and the Act Concerning Acceptance of Contribution, Deposit and Interest⁸. Following the first meeting, the conference was held every month. At these meetings, the necessity of a new legal infrastructure concerning digital cash, the prevention of forgery and the improvement of users' security were discussed⁹. However, on the 11th meeting in May, while some members still asserted that a new law that regulates what firms are able to issue digital cash was needed in order to prevent illegal transactions, others claimed that such legislation would make it difficult for new firms to enter digital cash businesses.

The MOF and the BOJ in particular thought that they did not have to hasten new legislation, because they believed that digital cash would not be widely used that soon in Japanese society, since the use of cash was so widespread and established. Of course, some argued that it was the lack of the legislation that had prevented the diffusion of digital cash in Japan. Whether this was true or not, the beliefs of the MOF and the BOJ have been proven to be wrong¹⁰.

In September 1997, the MOF debated the creation of a new banking license (the Type 2 banking

license), which would permit digital cash issuers to engage primarily in the settlement business, thus leaving traditional banks to engage in other businesses like deposit taking and loan offering. The MOF intended to promote the new entry of manufacturers and distributors into the digital cash business by introducing a laxer license. In the same month, the government established a research section on e-commerce in the Advanced Information and Telecommunication Society Promotion Headquarters and held the first advisory meeting to discuss the following subjects:

- 1) Substantive laws and electronic confirmation.
- 2) Cipher technologies.
- 3) Means of electronic settlement such as digital cash.

Furthermore, the Committee for Financial System Research, at its general meeting late in the same month, decided to set up a conference to consider new legislation that would become necessary due to the diffusion of digital cash and electronic settlement in the future. The conference discussed the standards required of a digital cash issuer and an attestation institute as well as user protection. However, the focus of the discussion was not on the legislation itself, but rather on preparing for future legislation.

Subsequently, the movement of legislation became stagnant. As indicated in sections 3 and 4, it was due to other efforts, rather than legislation, that led to the promotion of diffusing electronic payment means (e.g., digital cash).

2.2. Period of large-scale experiments (1998~2000)

The last three years of the 20th Century were characterized by several large-scale experiments on the electronic settlement system and digital cash. One of the reasons that large scale experiments were necessary was to collect as much data on consumers as possible. Another important reason was related to the intrinsic nature of money, the very object of the experiments. Digital cash cannot be regarded as functioning like money until it circulates to a large enough extent. Thus, it is possible to state that banks and firms would never obtain meaningful data about digital cash as long as consumers use digital cash in a narrow *laboratory*.

(1) Large scale experiments in the Metropolis of Tokyo

The “Shibuya Smart Card Society” was begun on July 16, 1998 (and was completed at the end of October 1999). This project was important for the following reasons. First, it was the largest digital cash experiment in Japan in those days. Second, its experimental area was the center of the Tokyo metropolis.

In this project, customers were able to use a smartcard named “Visa Cash” issued by *VISA International* at about eight-hundred locations (such as department stores and restaurants) within a radius of 1 kilometer from Shibuya Station. Forty-six institutions, including domestic city and regional banks, credit associations, manufacturers, credit card corporations and *VISA International* took part in this project¹¹.

The records of the project achieved by its completion were reported as follows: Visa Cash was used 89,935 times, the total amounts of the transactions were 116.452 million yen, the cards were reloaded 12,808 times, the total amount of reloading was 103.959 million yen, and the number of IC cards issued was 120,626¹². It is difficult for us to judge only by these results whether the experiment was successful or not. However, it is at least possible to say that the Shibuya Project did not immediately and directly lead to practical businesses. For example, Tokyu Department Store, one of the participants of the project, had already announced in February 1999 that it would dismantle all of the exclusive terminals at the time of the project’s completion. Furthermore, except for internal credit card corporations and a small number of city and regional banks, most financial institutions and all manufacturers proclaimed their intention to withdraw from the system by the end of the project. It is possible that the introductory costs and maintenance costs proved to be significant expenses for the participants, and offset the increase in income. Nevertheless, *VISA International* and other several domestic financial institutions likely gained useful data and operational experience from this experiment.

In parallel with the Shibuya project, another large digital cash experiment in the metropolitan area named “Shinjuku Super Cash” was implemented. Twenty-four private financial institutions in cooperation with NTT established an incorporated body called the “Super Cash Council” and began an empirical experiment with 100,000 monitors at department stores, convenience stores, gas stations and other stores in the Shinjuku area. Regrettably, without reporting on its results, the experiment finished as scheduled in May 2000.

(2) The MPT's project in Saitama Prefecture

Before these large experiments within the Tokyo Metropolitan area began in October 1997, the Ministry of Posts and Telecommunications (MPT) began its five-year experiment on a new type of digital cash developed by the BOJ and NTT. The intention was to use digital cash at both real and virtual malls. City banks (including Asahi, Daiwa and Tokai Bank), the Zenshinren Bank, Shinchosha (a large publisher), and several telecommunication companies (NTT and KDD) cooperatively participated in this project. This experiment was first begun at virtual malls, and in February 1998 the real side experiment began in Ohmiya City (present Saitama City), Saitama Prefecture. Initially, only fifty-five stores around the JR Ohmiya Station participated. In this experiment, customers were able to use the IC-card both as an ATM card for Postal Savings and as a prepaid card at department stores, convenience stores, large chain stores, ticket slot machines at the JR Ohmiya Station and at public telephone booths.

The MPT experiment in Ohmiya City has steadily expanded its scale and range of businesses since its inception. For example, four domestic credit card corporations (e.g., JCB) expressed the desire to participate in the experiment in October 1998, and in February 1999, MPT and *VISA International* came to an agreement that they would integrate the empirical experimentation in Shibuya and Kobe City into the project in Ohmiya City. According to an interim report in August 1999, one and a half years after the project had begun, the practice area had been expanded to neighboring cities (Urawa and Yono City). Two-hundred eighty-six stores participated in this project, and about 900 terminals were equipped to handle the cards. Sixty-four thousand cards were issued, and the total transactions amounted to 103.0 million yen.

(3) Other large scale experiments during this period

The other large scale digital cash projects were *Smart Commerce Japan* in Kobe City, mentioned in Table 1, and a new settlement system established by the cooperatives of 59 universities in the Kanto-Koshinetsu District collaborating with NTT Data Telecommunications and city banks such as Tokyo-Mitsubishi, Daiichi-Kangyo and Fuji. The students at these universities could use the IC-card as digital cash for payment at shops of the University Co-ops. In this system, a student could electronically transfer funds from his bank account to his IC-card through a terminal (a

special ATM) that was installed on the campus, and could use the card as a prepaid card when buying writing materials and books, food, and other items. A peculiarity of this card was that it could also be used as a student identification card¹³.

(4) Provisional evaluation for these large scale experiments

Making a final evaluation for the large-scale projects mentioned above is impossible until digital cash diffuses sufficiently in cash-oriented Japanese societies. Nevertheless, we think it possible to point out the following at the present stage;

- 1) It was premature to conclude that it was possible for a nationwide diffusion of digital cash to occur based on the success of an experiment, as long as the available area of digital cash was limited to one or several cities (or wards, which are urban areas).
- 2) Cost problems could not be overcome by enlarging the size of a project.

However,

- 3) In the sense that these projects together with other small and medium scale experiments could provide opportunities for examining various new and applied technologies, they might possibly contribute to the commercialization of the digital-cash-related technologies.

(5) Support by the Government

During the period 1998~2000, the Japanese Government did not reform legislation, but they did begin to support IC-card related industries to develop an electronic settlement system in earnest. The Ohmiya project by the MPT was one such effort.

In August 2000, the IT Revolution Sub Committee affiliated with the Diet Members' Union of the Liberal Democratic Party (the LDP, which was the political party in power in Japan) concerning informational industries proposed that IC-card standardization among ministries should be progressed in order to manage individual information by a unified computer system, and that the obligation of document issue had to be exempted for electronic commerce transactions. In October 2000, the Political Responsible Persons' Conference of the Government proposed that public services, including education, transportation, medical care and other administrative services, be provided through a light-speed Internet circuit, and that IC-cards would be a useful method in this type of society. These proposals encouraged the government to realize "Electronic Government

Planning”¹⁴ by the end of fiscal year 2003.

The other governmental efforts made for the diffusion of electronic settlement and digital cash are listed in Table 2, as are the efforts made during other periods (before 1998, and after 2000). To varying degrees, these efforts seemed to have led to the full-scale practical use of digital cash in the private sector with a time lag of several years.

Table 2: Governmental Contributions Related to the Diffusion of IC-card and E-money

Subject	Year	Content of Activity
The Government or LDP	1997	Establishment of a research section on e-commerce in the Advanced Information and Telecommunication Society Promotion Headquarters. (Sep)
	2000	The sub committee of LDP Diet Member’s Union for IT industries proposed the standardization of IC-cards among ministries. (Aug)
		The Political Responsible Persons’ Conference of the Government gave the outlines of preparations to realize the Japanese version of the IT revolution. (October)
	2001	Establishment of the Headquarters on IT Strategies. (Jan) “E-Japan Planning” with over-priority was suggested. (May)
	2002	Three bills related to Electronic Government and Local Government were passed by the Cabinet. (Jun)
Ministry of Finance	1995	Organization of a council with private banks for the introduction of digital cash. (Oct)
	1996	Established the Joint Conference on Digital Cash and Electronic Settlement. (Jul) Started to revise the Prepaid Card Regulations and the Act Concerning Acceptance of Contribution, Deposit and Interest. (Jul)
	1998	“The Report of the Joint Conference on Digital Cash and Electronic Settlement”. (Apr)
	1996	Established two small committees for studying electronic commerce. (Dec)
Ministry of International Trade and Industry (~2000)	1998	Spent 42,500 million yen on 158 topics adopted in “the Developing and Collaborating Businesses of Advanced Information System”. (Dec)
Ministry of Economy, Trade and Industry(2001~)	2000	Set up a joint project with the European Commission for establishing standardized methods for a next generation IC-card system. (Jun)
Ministry of Transport (~2000)	1996	Started supporting the development of an IC-card commuter ticket system. (Oct)
Ministry of Land, Infrastructure and Transport (2001~)	2001	Developed a multi-functional IC-card available both for getting on public transportation and for shopping. (Nov)
	2003	An empirical experiment was begun on the E-Check-in System. (Jan ~ Mar) Achieved development of a system in which a portable telephone with a built-in IC was available for getting on trains and for ETC (Electronic Toll Collection System) of a superhighway.
	2004	Started an empirical experiment for an IC-card commuter ticket in east Asian countries. (Feb)
Ministry of Welfare (~2000), Ministry of Health, Labor and Welfare (2001~)	2000	Began to examine changing from paper-based health insurance certificates to IC-card versions. (Apr) Embarked on the diffusion of an IC-card as a health insurance certificate and as a resident's card. (Oct)
	2003	Began a model business for care insurance certificate IC-Cards. (Sep)
Ministry of Posts and Telecommunications (~2000)	1997	Started a five-year experiment on a new type of digital cash available for both real and virtual malls, but at the beginning only in virtual malls. (Oct)
	1998	Extended its previous digital cash experiment to real malls in Ohmiya City. (Feb)

Japan Post (2003~)	2000	Embarked on joint development of a system in which a portable telephone could be used as an IC-card terminal, in collaboration with several manufacturers. (Mar)
	2003	Japan Post started to issue Postal Saving Cards loaded with Edy's Functions. (Aug)
Ministry of Internal Affairs and Communications	2002	Revised the ministerial ordinance related to radio wave laws and abolished business licenses for the remote type IC-card. (Jul)

2.3. Period of real commercialization (2001 ~ Present)

With regards to electronic settlement and digital cash, we can regard the period since 2001 as a time of commercialization. We would like to explain several representative cases below.

(1) The appearance of the Japanese original digital cash “Edy”

One of the most remarkable cases is that of “Edy”. It does not mean an IC-card, but an electronic value which can be filled up using various kinds of IC-cards and portable telephones with built-in ICs that adopt a non-touching (or remote) technology method called “FeliCa,” which was developed by Sony. The empirical experiment of Edy was begun at Gate City Ohsaki in front of JR Ohsaki Station in July 1999, and the genuine commercial service of Edy began in November 2001 after several successful experiments were conducted. The management and promotion enterprise of Edy is Bitwallet, which is now financed by sixty-one (initially eleven) corporations such as Sony and NTT Docomo Telecommunications.

Edy service providers consist of Bitwallet as a core enterprise, seven IC-card issuers, two card printing makers, thirteen value issuer firms (e.g., credit card corporations and city banks), thirty-seven technical operating firms which provide Edy terminals, twenty-seven solution firms which supply vending machines that can accept Edy, and more than 13,000 chain stores, including online shops, as of the end of December 2004. Chain stores in all prefectures now accept Edy. The categories of business have also been extended to various types of industries, such as food and drink, shopping, amusement parks and arcades, medical clinics, and other places. A report released by Bitwallet stated that by the end of December 2004, about 6.8 million IC-cards (including cellular phones) that can use Edy had been issued, and the number of transactions using Edy had gone up to about five million per month. From the Shibuya Smartcard Society’s experience, where the average

per-transaction amount was about 1500 yen, the amount of use per month may be about 7.5 billion yen total.

At present, Edy still remains a closed-loop system, not an open loop one¹⁵. All information concerning the transactions settled by Edy has been designed to be concentrated in an operational center of Bitwallet, and it is impossible to exchange Edy values freely among customers, stores and firms. However, there is an important difference between Edy and former closed-loop digital cash systems. Edy can be purchased on credit, and Edy cards can be charged in exchange for cash; thus, a bank balance equal to the amount of payment by Edy isn't necessarily needed.

(2) Suica: digital cash evolved from a carfare IC-card

Another widespread digital cash IC-card in Japan is called “Suica,” which has already been mentioned above. There are two kinds of Suica, a Suica-Io-Card (ticket), and a Suica Pass. East Japan Railway issues these cards. They were introduced at 424 JR stations in and on the outskirts of the Tokyo Metropolis in November 2001, after several empirical experiments were conducted in the Tokyo Waterfront Area. The number of Suica holders has increased from 2 million (two months after the introduction) to more than 10 million in October 2004. The reasons for the diffusion of Suica are as follows. First, since December 2002, the card has been available outside the metropolitan Tokyo area (for example, in the Sendai district) and at many railway and Shinkansen stations. Second, the card has also been available on the Tokyo Waterfront Railway and the Tokyo Monorail stations since March 2002. Therefore, it is very convenient for people in Tokyo to use Suica. Third, since August 2004, Suica can be used as an ICOCA, which is a similar IC card ticket and commutation ticket issued by West Japan Railways (e.g., in the Osaka District).

Of course, if Suica was merely an IC-card corresponding to the transport system, it would never be able to compete with Edy. However, besides functioning as a ticket and a commuter ticket, Suica can be used for financial transactions. In July 2003, “View Suica”, which is a hybrid Suica card, was introduced, making it possible to credit the deficit in a carfare IC-card. And in March 2004, Suica became available for shopping at station stalls and restaurants in station yards. Moreover, since September of 2004, the card can be used to pay for goods at convenience stores on the street. The number of Suica cards issued with a digital cash function (other than carfares) was up to 4,430,000 at the end of October, 2004. As of the same time, Suica could be used as a ticket or a

commuter ticket at 847 stations of East JR, West JR, the Tokyo Waterfront Railway and the Tokyo Monorail, and as digital cash at 653 stores such as NEWDAYS or Family Mart. East JR intends to extend the use of the card to the Niigata area (within the 2005 fiscal year). In rivalry with Edy, “Mobile Suica,” which uses a portable phone as a loading device, is also going to be introduced (within the second half of FY 2005)¹⁶.

The way in which East JR expanded the usage of IC cards is instructive for international readers. JR first introduced the IC-card ticket (Suica) to its customers to show them how convenient and useful the card could be, and once that had occurred, East JR added digital cash functions to the Suica.

Finally, we have observed that the scales of the commercialized projects (the Edy and Suica) have already become much larger than any former experimental projects (see Table 3).

Table 3: The sizes of digital cash projects in Japan

		Number of Issue	Amount of use (1000 yen)
Experimental Projects	Shibuya Smartcard Society	120,626(98.07~99.05)	116,452(98.7~99.5)
	MPT project (Ohmiya City)	64,000(98.02~99.08)	103,000(98.2~99.8)
	Smart Commerce Japan (Kobe City)	24,468(97.10~98.04)	56,000(97.10~98.4)
Commercialized Projects	IC-card corresponding to the Edy	6,800,000(01.11~04.12)	7,500,000(per month)
	Suica Card with prepaid function	3,070,000(01.11~04.06)

(Note) *The data concerning the amounts used in commercialized projects are as of the end of 2004.

**The amounts used in commercialized projects were estimated by the authors.

(3) Governmental activities related to IC-card since 2001

In January 2001, the government started up the IT Strategy Headquarters, and in June of that year, the headquarters settled on the E-Japan Emphasis Plan aiming for the establishment of the most advanced IT nation within five years. The following applications of IT were planned. The government provided several IT model districts with a forefront electronic infrastructure. In those districts, 1) an election would be conducted by electronic ballot, 2) people would be able to receive electronic medical services (for example, receive a diagnosis via the Internet), 3) the management of emigrants and immigrants in the airport would be easily completed with IC cards, and 4) a

system in which people can operate home appliances by remote control using a cellular phone would be introduced¹⁷. The Cabinet Council introduced three bills concerning the completion of paperwork electronically for the government and municipality, making it possible to file registrations of one's marriage and final tax returns online, and to obtain a copy of one's resident's card from one's PC.

Table 2 shows other governmental efforts made during this period. The government efforts listed in Table 2 include governmental and administrative activities which might not seem to have any direct relation to digital cash. However, it is notable that these efforts were important in considering factors that have encouraged broad use of digital cash. Various kinds of IC-cards, including digital cash smartcards, have been diffused due to the development of hybrid (or multifunction) technologies.

3. The factors for the spread of digital cash in Japan

3.1. Public sector's leadership

As stated in the previous section, the rapid spread of digital cash in Japan has been highly dependent on the overall support provided by the national and local governments. The national and local authorities assisted in diffusing IC-cards, but not in promoting electronic settlement by digital cash, which is just one of the information technologies. However, because the government provided support for the entire IC-card field, the diffusion of digital cash occurred as a result. One of the factors in this diffusion was hybrid technology which brings about the spread of digital cash together with other IC (card) usages such as for transportation, medical treatment, and administrative services. In addition, another factor is the fact that the increase in the demand to use IC cards in new ways has significantly reduced the production costs of IC-cards. Therefore, financial institutions and other companies have found it easier to introduce IC technologies (e.g., electronic settlement) into their businesses. We describe this in detail in the next sub-section.

However, the entire support of the public sector would have resulted in failure if the private sector had not made its own efforts. First, many private enterprises had already accumulated experiences

and advanced technologies related to electronic settlements before the participation of the public sector in the field (i.e., in 1995, as mentioned at the head of section 2). Examples of Japanese original technologies concerning electronic settlements are listed in Table 4. Second, private firms in Japan have made efforts to develop electronic settlement technologies to better serve the customers and market.

Table 4: Original Japanese technologies related to electronic settlement

Year	Technology name	Companies or governmental bodies developed by	Content of system
~1994	A remote-type IC-card	Matsushita Electric and Others	It can remotely read and write on an IC card.
1997	An IC-commutation ticket	Ministry of Transport, Others	Allows passengers to pay for an override charge along with various purchases.
~1997	A common-card both in real and virtual malls	VISA International, Toshiba and others	It is an IC-card available both in real malls and virtual malls.
~2000	Cellular phone with digital cash function	NTT Docomo, Sony and others	Digital cash functions are built into a cellular phone.

3.2. Decrease of IC card issue costs: innovation and expansion of the market

As indicated in the example of the Shibuya Smartcard Society, the introductory costs and maintenance expenses of the electronic settlement system were major obstacles to the spread of digital cash. Of all such costs, the cost of issuing IC-cards was especially expensive. When Ogaki-Kyoritsu Bank introduced IC-card digital cash as an experiment at Soft-pier-Japan (Ogaki City, Gifu Pref.) about ten years ago, the issue cost per IC-card was about 1,300 yen, ten times the cost of a standard cash card¹⁸. Now, the issue cost per IC-card has fallen below 150 yen. Therefore, it has become much easier for financial institutions to begin electronic payment services.

Needless to say, the innovations in the technology have contributed a great deal to the increasing use of IC-cards during the past decade. However, as mentioned above, the expansion of the IC-card market has also contributed a great deal to the decrease of IC-card issue costs through a scale merit (i.e., the reduction of manufacturing costs by mass production). Currently in Japan, there are six fields in which IC-cards are in demand: 1) finances, 2) traffic and transportation, 3) administrative tasks, 4) identification (ID) cards, 5) communications, and 6) medical care. Among these, the areas

related to payment-and-settlement are 1), 2) and part of 6). But we have to consider the fact that by slight technical changes, an IC card production line can be corresponded to the functions in all of these areas. Therefore, even if a demand increases not in the area of digital cash but in other field of IC-card, through a scale merit concerning IC cards' common components, the issue cost of digital cash could be reduced as the result. In other words, if the demand for IC cards in any field increased, the issue cost of digital cash would decrease.

3.3. What has changed by the introduction of the Edy and Suica cards?

At present, there are two types of digital cash systems in Japan. One is a regional promotion type based on a local area or a local shopping street, which can only be used on a certain street or certain shops. The Apron Card for the Nishi-shindo-nishikikai shopping street (Kyoto City) and two smartcard systems in Nagano Prefecture are typical examples of this type of digital cash system. This system is self-concluded within the consumer's living space, and has been commercialized on their terms. A main purpose of this system is to prevent outflows of customers to large-scale shops in the suburbs or to the nearest large cities. Therefore, these projects seem to have reached this initial goal, at least to some degree.

However, Edy, Suica and ICOCA are used in larger areas. The plan is for this large-area type system to be used not only in Tokyo and Osaka, but throughout the entire nation. Although these systems have not been open-looped yet, their availability over the whole country will undoubtedly improve their general acceptability, which is one of the most important characteristics of money. Therefore, the wider the regions where one can use these currencies, the more people would want to use them. For example, if a businessperson travels around the whole country, he or she would be more likely to use digital cash if it is available from Hokkaido to Okinawa.

It is relatively easy for firms or stores to introduce Edy into their business because of its correspondence to all IC-cards or cellular phones that use the FeliCa method. However, the advantage of Suica (or ICOCA) is that it is linked to the JR rail system. The success of Suica is due to the East JR's strategy for covering all places that businesspersons often visit.

3.4. Conveniences that have arisen by multifunction (or hybrid) types of Smartcards

Customers will never accept digital cash if they are unaccustomed to using it. Only after they acknowledge that its usefulness is greater than that obtained from cash or a credit card will they want to use it. Thus, whether digital cash offers greater advantages than cash or credit cards do is crucial for the diffusion of digital cash.

For example, the three regional type digital cash systems mentioned above were commonly accompanied with a point service function in addition to an ordinal prepaid function. A typical point service for shopping is to give points to customers who buy something with digital cash. For example, a customer obtains one point when he purchases something costing one-hundred yen. In the Apron Card and other systems, a customer's purchasing information is automatically converted into equivalent points, and these points are added to the prepaid value of the IC-card. For the Apron Card, 4 yen points (four times the usual number of points) are given for the purchasing price of one-hundred yen. Thus, the point service function gives premium value to digital cash.

Therefore, the following inequality determines whether digital cash is used or not;

$$\text{Utility from using cash (or credit card)} <$$

$$\text{Utility from using digital cash} + \text{Premium value given to digital cash usage}$$

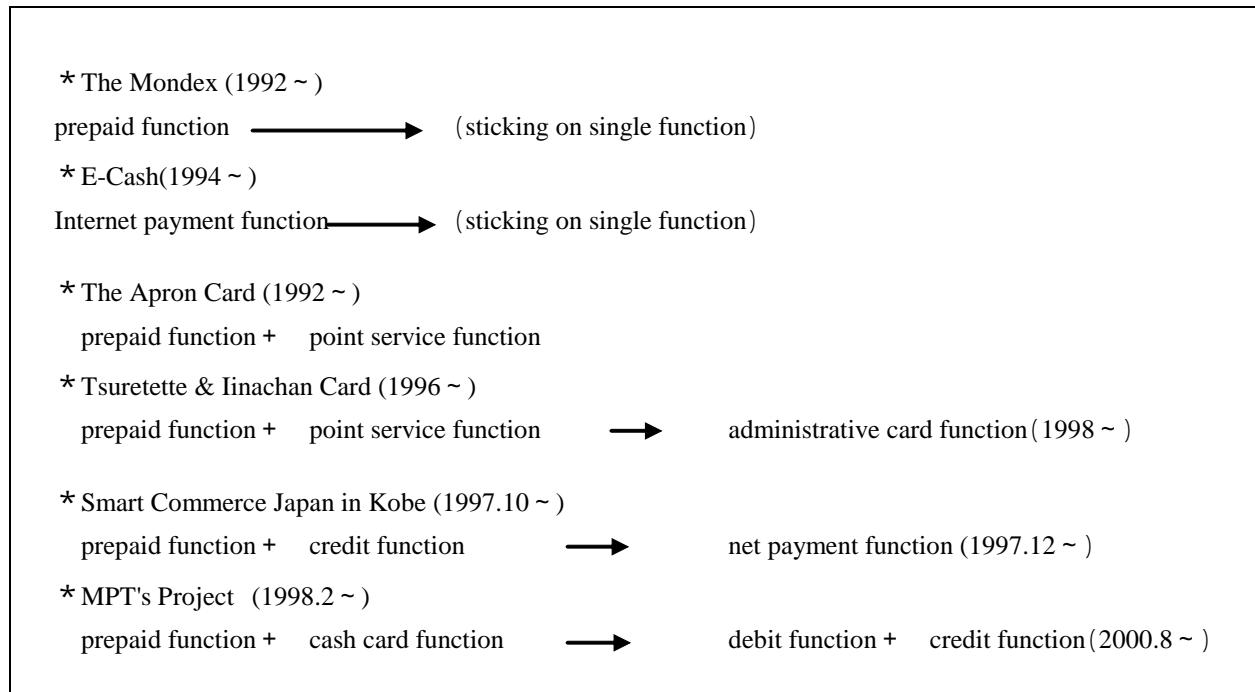
When this inequality is satisfied, the customer will be willing to use digital cash. The premium makes up for the costs to customers for digital cash usage, costs which include inexperience, operational trouble and uneasiness. The premium makes customers feel payments by other than digital cash causing losses. The premium value makes customers feel that if they pay for things using actual cash, a credit card, or by some other means, they'll suffer economic losses. It is possible that if the Mondex (U.K.), the first IC-card type digital cash in the world, had had a point service function (without sticking only to a prepaid function), it would have become a more popular card worldwide. Mondex's failure was inevitable, because the inequality was not satisfied because Mondex did not offer any premiums to customers.

Similarly, E-Cash (Digi-Cash Co., U.S.), the first network type digital cash in the world, committed the same kind of failure. It competed with credit card companies by using superior encryption technology on the Internet. When the bankruptcy of Digi-Cash Company was declared

in November 1998, a journalist analyzed the cause of the failure as due to the following. As Internet consumers became accustomed to using credit cards for online shopping, the micro-payment market became smaller and smaller¹⁹. However, this analysis only presented one side of the facts. The more important cause of the failure is that a customer could use a credit card both in real shops on the street and in virtual malls on the net, while she or he was not able to use E-cash other than for online shopping. Therefore, despite the advanced anonymity provided by E-Cash, customers knew that the utility of using E-Cash was much less than that obtained from using a credit card. In Japan, hybrid technologies have been applied on synthetic IC-cards that include credit, debit and cash-card functions together with a prepaid function available both at real stores and online. Japanese firms collaborating with the public sector have selected a *symbiotic* relationship rather than a *competitive* one in this respect. An interesting fact is that credit card companies have mainly promoted hybrid smartcards in Japan.

Currently, nationwide type cards function as credit, debit and cash cards. However, regional promotion type cards have an administrative function in addition to a point service function (see Figure 1). In sum, these two types of digital cash have evolved independently in Japan.

Figure 1: A comparison of functions in each digital cash system



3.5. Innovations in techniques

Hybrid and other new modes of smartcards have become available due to various technological innovations. The technologies have advanced rapidly. Recently, for example, a new system was developed that makes it possible to transfer money directly from an ATM to a cellular phone. In addition, various ID (identification) techniques such as fingerprint attestation, face attestation, iris attestation, and vein attestation have been developed in order to improve consumers' reliance on electronic settlements,

In the World Congress on Information Technology (WCIT) 2004 held in Athens, the electronic tender system applied in Yokosuka City in Kanagawa Prefecture as a public sector and East JR's Suica as a private sector were awarded the IT Prizes of World Information Technology and Services Alliance (WITSA). Because the prize is reportedly the most important in the IT field worldwide, the Japanese public and private sectors were recognized as having the highest level of smartcard technologies.

3.6. Summary

In this section, we consider the factors that have contributed to the rapid diffusion of digital cash in the past few years in Japan. The cooperation between the government and private companies has been the most important factor leading to the diffusion of digital cash. In addition, the following various factors also contributed to the rapid diffusion.

- 1) The introductory costs and operational expenses of electronic payment systems have been dramatically reduced, due to both improvements in manufacturing technologies and the increase in the demand for IC-cards in various areas beyond financial fields.
- 2) Since the appearance of Edy and Suica, digital-cash-available regions and stores have expanded with increasing speed.
- 3) The development of hybrid technologies has made digital cash more convenient.
- 4) Remarkable innovations in attestation technology have improved reliability for consumers.

4 . Unsolved problems to ensure a stable digital cash system

4.1. What are the remaining issues?

What problems will come to light after the spread of digital cash and other consumer electronic settlements? In this section, we consider the problems that remain to be solved to ensure stable and reliable digital cash system.

First, we should consider the problems that used to be obstacles to the diffusion of digital cash but have been forgotten because of the real spread of digital cash. In fact, these problems were not solved, but rather avoided. For example, as mentioned in the previous section, the costs of digital cash usage have been reduced and the range of regions and stores where one can use digital cash and its conveniences have significantly increased. As a result, the commercialization of the digital cash system has greatly progressed. However, have security and privacy problems been eliminated sufficiently by the progress of ID techniques or remote-type IC-card technologies? Of course, these techniques would, to some extent, contribute to solving these problems. But remote technologies can be abused (individual information and the value of money can be stolen remotely). Additionally, ID technologies in general are also not perfect, and camouflages by various means are still possible. Furthermore, there still remain other problems, such as money laundering and tax evasion. Thus, further improvements of the technologies in this field are needed, as are solid restrictions.

Second, we should not forget confidence problems regarding digital cash issuers. Edy, Suica and other types of commercialized digital cash in Japan are all secured. The values are tentatively guaranteed by the exchange of bank deposits or the cash equivalent to the digital value. However, it is possible that an event occurs in which digital cash as a whole might lose public trust and would trigger runs upon a digital cash issuer. For example, the issuer's failure and mechanical troubles which make digital value information destroyed or unreadable may provoke runs on the issuers. A mechanical trouble, although not a very serious one, actually occurred. On October 26, 2002, an automatic ticket machine collected 67,380 yen in total from 290 Suica Pass users by mistakes.

Finally, a money supply controllability problem accompanied with the diffusion of digital cash is of concern to the central bank. When the amount of circulation is relatively small, money supply controllability is less likely to be damaged. But it is impossible to disregard this problem once

electronic money becomes widely used. It is necessary to examine the controllability problem before it is too late.

4.2. Further government efforts

As shown in Table 2, legal reforms by the government were made during the start-up period (1995~1997). However, since 1998, the government has been inactive in passing legislation. A five-year gap in administrative action in this field suggests that the primary policy of the government was to spread smartcards.

The MOF published the Report of the Informal Gathering for Discussions on Digital Cash and Electronic Settlement. Its primary goal was first to strive for the development and diffusion of electronic settlements and digital cash. The report recommended that legal and institutional frameworks be structured to encourage private firms to design and develop a digital cash system as freely as possible. The report also maintained that it would be desirable to prepare new laws to enable various firms other than depository financial institutions to issue digital cash. The Japanese government's aggressive policy contributed a great deal to the diffusion of electronic settlements all over Japan. However, we would like to note that the Japanese approach stood in contrast to the approach of the European Central Bank during the same period²⁰. The ECB claimed that the issuer of digital cash should be limited to banks, whereas the MOF listed only two points as requirements for a digital cash issuer: 1) financial soundness and 2) capabilities in the technique required and in the business practices necessary. In fact, the MOF did not submit the Digital Cash Bill to the Diet. Therefore, no legislation regarding digital cash issuers has been passed.

In 2003, the Ministry of Internal Affairs and Communications and the Ministry of Economy, Trade and Industry began to study a defense plan to protect confidential information stored in an IC card. In 2004, the Financial Services Agency (FSA) also began to consider a user protection plan. For example, a digital cash issuer would be obligated to hold cash and deposits more than half of the amount of the outstanding values of the digital cash.

It is not clear how the BOJ as another financial supervisory authority evaluated the recent diffusion of digital cash. Of course, as long as the main types of digital cash in the country are the closed-loop type, it is possible to think that the monetary policy will not be influenced so soon and

so severely, no matter how widely digital cash use will spread. However, the BOJ has to take the possibility into consideration that types of digital cash like Edy and Suica will open their loops after they become as popular as cash. In preparation for "that time", the BOJ must consider the following points:

- 1) Qualification for digital cash issuers, to ensure that the digital value is backed by cash and deposits.
- 2) Enhancement of the statistical data concerning digital cash.
- 3) Various simulations of the trends in the future.

5. Conclusion

In this paper, we have examined the factors involved in the recent spread of digital cash and the problems with digital cash projects in Japan that still remain to be solved. First, we took into account the history of digital cash projects of Japan during the past decade, ranging from the initial experiments to the recent commercialization efforts.

With regards to factors accelerating the diffusion, we found that the government did not pass new laws, but instead supported the experiments and commercialization. At the same time, we found that the manufacturing costs of smartcards were significantly reduced through expansion of IC-card markets and technological improvements. Furthermore, the most fundamental causes for diffusion that we pointed out are (1) increasing convenience of digital cash usage, (2) expansion of available districts of digital cash, (3) innovations in ID technologies, and (4) close cooperation between the public and private sectors.

Concerning the remaining issues, we enumerated consumer protection problems, confidence problems of digital cash issuers, the money supply controllability problem if digital cash turns into an open-loop system in the future, and other criminal issues such as money laundering.

The Japan of today is not necessarily a world leader in all IT industries. However, in the digital cash field, Japan is one of the most advanced countries in the world. Thus, if Japan is to become a "good model" for other countries in this field, policy efforts must be made to remove the various factors destabilizing the digital cash system.

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Notes

¹ Yamori and Nishigaki (2000) reviewed these opinions.

² Of course, at the same time, some digital cash projects in other developed countries were used in real economic transactions. For example, an electronic settlement service through the Internet was innovated by *First Virtual* in the United States, and IC-card type digital cash in Finland and Denmark, as well as in other countries, were in use before 1995.

³ It was one of the largest private banks in Japan. It was merged into the Mizuho Financial Group in 2000.

⁴ Like Fuji Bank, these banks were also major private banks in Japan. All of them were merged into mega financial groups later. Daiichi Kangyo and Fuji were merged into the Mizuho FG. Sakura Bank was merged into Sumitomo Mitsui Banking Corporation in 2001, and Asahi Bank joined the Resona Group in 2002.

⁵ These facts suggest that many Japanese industrial firms had already developed innovative techniques that were necessary for electronic finance.

⁶ This system consisted of two parts. The first part involved electronic attestation (i.e., inputting one's credit card number when ordering goods or services online). The second part involved credit card settlement (i.e., sending electronic information, such as the credit card number, to the credit card company). The method of settlement used was the "SET" system, upon which VISA International and Master Card had previously agreed.

⁷ A maker of PC-related commodities in Sapporo City (Hokkaido).

⁸ The regulation, abbreviated to "shusshi-hou", prohibits anyone from accepting deposits without a license. Therefore, if a non-bank issues digital cash in exchange of traditional money, the issuing of digital cash might be regarded as deposit taking, and therefore illegal for non-bank institutions.

⁹ The conference participants discussed in January who should be an attestation institution that proves the counter party's identity, and in March it focused on the legal rights and duties in electronic payment.

¹⁰ As another legislative action, in December 1996, the Ministry of Justice established two small committees to study electronic commerce. The committees began to discuss digital cash systems and to consider how to revise the related civil and commercial laws.

¹¹ There were four types of smartcards: the exhaustible type, repeatable type, IC prepaid and credit card combined type, and IC prepaid and bank ATM card combined type.

¹² See <http://www.edit.ne.jp/~arita/jec/smartjapan.html>.

¹³ However, it did not function outside campuses.

¹⁴ It was the plan that the national and local governments would process their administrative affairs through digital or electronic systems.

¹⁵ Closed-Loop Type Digital Cash System is a system in which a digital cash issuer (an originator) should transfer the same amount of money as the sum paid by a digital cash user at a shop to the deposit account of the shop. In this system, the digital cash value exchanged for cash or deposits must be flown back to the issuer through a member bank after each transaction. Open-Loop Type Digital Cash is a system in which digital cash value once paid by a customer can circulate from hand to hand without flowing back to the issuer. In this case, the digital cash provides almost the same function as real cash or deposits.

¹⁶ Suica, like the Edy system, still employs a closed-loop system. However, Suica and Edy cards can be charged in exchange for cash. Therefore, there is a strong possibility that Suica can replace cash as soon as it becomes open-looped.

¹⁷ Most of these technologies now have been realized (i.e., at the end of fiscal year 2004).

¹⁸ See Senda (1997), p.36.

¹⁹ See <http://hotwired.goo.ne.jp/news/news/business/story/1594.html>.

²⁰ See European Central Bank (1998).

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