f i ® s t m ¤ ñ d @ ¥
PEER-REVIEWED JOURNAL ON THE INTERNET

POSSIBLE ECONOMIC CONSEQUENCES OF DIGITAL CASH

By TATSUO TANAKA

Abstract

Digital cash brings benefits as well as problems. One major advantage of digital cash is its increased efficiency opening new opportunities, especially for small businesses. On the other hand, it will encourage potentially the worsening of problems over taxation and money laundering. In turn, these problems may alter foreign exchange rates, disturb money supplies, and encourage an overall financial crisis.

The transnationality of digital cash - the ability of digital cash to flow freely across national borders - encourages these benefits and problems, and could have significant repercussions internationally.

From an economic view, this transnationality is the most important characteristic of digital cash. If digital cash behaved like traditional currencies, circulating within a national border and controlled by a central monetary authority, there would be few economic implications that would be worth analyzing. In this scenario, digital cash would be nothing more than a convenient transaction method such as a credit card.

However, digital cash's very transnationality has the potential to cause conflict between cyberspace and nation states. If digital cash spreads successfully in the next century, its history may be written as a transcript of economic battles between nation states.

Contents

Introduction

What are the economic consequences of digital cash? What are its implications from the view of economics? In recent years, several proposals for electronic cash have appeared in cyberspace. In several cases, forms of digital cash are already in use [1]. The economic consequences of these transactions have not yet been fully examined.

To some observers, one important economic consequence of electronic cash is the free issue of private currency by commercial banks or other non-firms [2]. However, if we look at the history of money, it is not easy to make privately issued currency credible in the eyes and wallets of the public. As long as there is competition between banks, private banks will sometimes become bankrupt. Nothing is more debilitating to the credibility of privately issued currency than bankruptcy.

The most important characteristic of digital cash is its transnationality. Digital cash does not recognize national borders. It is not controlled by any central bank of any nation state. The unprecedented efficiency of international payments with digital cash may indeed increase the instability of the global monetary system. This efficiency indeed may lead to conflicts between digital cash providers and users and the central banks of nation states.

Overview of Electronic Payment Systems

There are over a dozen proposals for electronic payment systems on the Internet [3]. To briefly understand these systems, let's us examine a few issues by trying to pay a bill via the Internet with a credit card. In comparison to using cash in the real world, transmitting a credit card number over the Internet might lead to the following difficulties.

First, there is the entire question of security. Credit card numbers may be viewed by unauthorized individuals because the Internet is an open system. In the real world, there are a number of means to minimize fraud. A customer using a credit card will usually opt to carry out transactions at trustworthy or familiar facilities, stores, and markets.

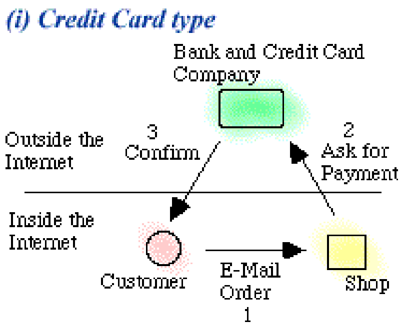
Second, credit cards can be used only at authorized stores. Unauthorized small businesses or individuals generally cannot carry out transactions with credit cards. In other words, credit cards cannot be used for peer-to-peer payment. Cash encourages peer-to-peer payments.

Third, credit card payments usually charge a small fee. Although this cost is low, it can be a significant cost when the payment itself is very small, such as less than 20 cents [4]. As a result, credit cards can not be used for micro-payments. Cash payments is used for even the smallest financial transactions.

Finally, receipts from credit card payments leave residual records of expenditures. Those who issue credit cards know exactly what kinds of goods and services have been purchased, as well as where and when they were acquired. In other words, user's expenditures by credit card can be traced while cash payments are untraceable.

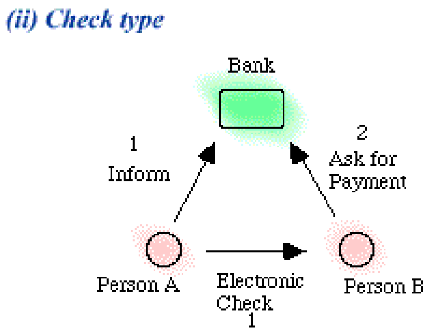
Electronic payment systems, more or less, try to cope with the above issues [5]. According to the extent to which these systems cope with these problems, I classify digital cash programs into three categories.

1. Credit Card Base Type
To minimize security risks and the loss of credit card numbers in transit, First Virtual Holding began a payment system in which users transmit passwords instead of credit card numbers when purchasing an item (See Figure 1-i) [6].



Customer sends his ID or encrypted creditcard number to the shop. Shop asks for payment to the Credit card company, which confirms customer by e-mail. After the confirmation, payment is done. Card number itself never goes through the Net.

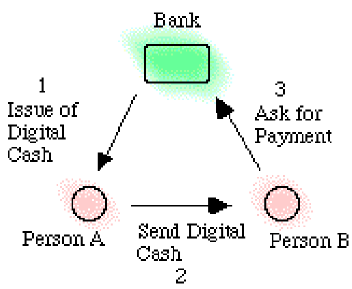
Security	X
Peer-to-peer	-
Low fees	-
Untraceability	-



Person "A" isues his electronic check. He sends it to person "B" and informs the bank of his check. Person "B" asks for payment to the Bank. After the confirmation, the bank transfers money from person A-s account to person B-s.

Security	X
Peer-to-peer	X
Low fees	X
Untraceability	-

(ii) Cash type



Person "A" asks the bank to issue digital cash. The bank issues digital cash and reduces his account by that amount. He sends it to person "B". Person "B" asks the bank for payment. After confirming that the digital cash is not double-spent, the bank increases person B-s account by that amount. Note that the bank cannot know who sent that digital cash to person B. (Untraceability)

Security	X
Peer-to-peer	X
Low fees	X
Untraceability	X

In this system, a user registers in advance with First Virtual to secure a password corresponding to a credit card number. With the purchase of goods or services on the Internet, only a password is transmitted to complete the transactions. After the actual purchase, a confirmation electronic mail message confirms the validity of the transaction. This system is simple and is already in use to some extent. Visa and MasterCard are planning a similar payment program using encryption instead of passwords.

These credit-card based solution solve only the security question. As Figure 1-(i) illustrates, the actual communication between the consumer and electronic storefront are addressed by this strategy. The transaction of real money remains to be done by conventional credit card transactions. These transactions require a fee. A peer-to-peer transaction is impossible. Certainly, the entire transaction is also traceable.

2. Check Type
Checks are closer transactionally to cash than to credit cards, because peer-to-peer transfers are possible. Micro-payments are possible as well though banks are reluctant to accept process micro-payments by checks thanks to the high operational cost of check clearance [7]. As a result, several proposals (CyberCash, NetCheck, and others) have emerged to invent checks on the

Internet, which would be transferable between individuals [8]. As Figure 1-(ii) shows, a customer opens an account in a bank on the Internet, and issues an electronic check to pay a bill. The recipient of this digital check sends it to the Internet bank to confirm and cash it. Security is guaranteed by both encryption and the bank's confirmation process with the issuer of the check [9]. This system permits peer-to-peer payments and reduces fees to some extent. But transactions are still traceable since a bank can track the actual use of the electronic check.

3. Cash Type
Cash transactions are untraceable and anonymous [10]. To achieve untraceability on the Internet, encryption has to be fully employed to prevent untraceable money from being easily copied and spent twice, a phenomenon known as double-spending. David Chaum as well Tatsuaki Okamoto and Kazuo Ohta have proposed untraceable electronic payment systems using advanced encryption technology [11].

The mechanism in this system is similar to an electronic check, but it prevents banking institutions from linking purchasers to specific goods and services (see Figure 1-(iii)). How does this work? First, an Internet user opens an account with real money at an Internet-based bank. The customer asks the bank to issue a certain amount of digital cash for use on the Internet. The bank issues this digital cash using encryption and deducts the funds from the established account. An example of a bank that performs these sorts of transactions is Mark Twain Banks, operating since late in 1995 [12].

This digital cash is a combination of two huge integers which have special mathematical relation. No other person or institution, but the bank, can imitate this relation. Any calculation that would attempt to duplicate this relation would take an almost infinite amount time in the absence of the bank's secret key.

When an individual uses digital cash, this unique data that defines the actual electronic currency is given to the merchant. The merchant in turn sends this data to the bank to confirm it. If the bank confirms it, the bank credits the merchant's bank account by that amount, or alternatively issues the merchant a sum of digital cash in the same amount. Only the bank can confirm that this data - or, digital cash - is legitimate and actually issued by the bank. Only the bank can verify that this that this data has not been used elsewhere, or double-spent. The bank cannot know who used the digital cash, as long as customers of the bank do not use it twice.

This payment system deserves the name of "cash on the Internet" because it is almost equal to a cash payment in terms of security, fee, peer-to-peer payment, and untraceability. I will now focus on this cash-type "digital cash."

Consequences of digital cash
With digital cash, financial transactions will become more efficient, which in turn will broaden new business opportunities. Problems? Certainly, taxing digital cash and the specter of money laundering are significant issues. Additionally,

digital cash could introduce instabilities to exchange rates and upset the overall money supply. Let’s first look at the primary benefit of digital cash.

Increased efficiency of transactions

Digital cash will make transactions more efficient in several ways. First, digital cash will make transactions less expensive because the cost of transferring digital cash via the Internet is cheaper than through the conventional banking system. To transfer money in the traditional way, conventional banks maintain many branches, clerks, automatic teller machines, and specific electronic transaction systems. Overhead costs for all of this bureaucracy is generated in part from fees for money transfers and credit card payments. Since digital cash uses the existing Internet network and the specific computers of its users, the cost of digital cash transfer is much lower, close to zero [13]. With the transaction completed within the Internet, the transfer fee and bank tips are zero, in case of the Mark Twain Banks [14]. This low cost for transactions enables micro-payments, like 10 cents or 50 cents, to be possible, which in turn may encourage a new distribution system and fee structure for music, video, and computer software. "Super distribution" is just one practical application [15]. This ability to finally handle micro-payments might also provide a solution for the payment of fees to authors and publishers for use of copyrighted materials in electronic form.

Second, since the Internet recognizes no political borders, digital cash is also borderless. Thus, the cost of transfer within a state is almost equal to the cost of transfer across different states. The cost of international money transfers, now much higher than transfers within a given state, will be reduced dramatically. For example, now it may take more than a week to send a small amount of money to a foreign bank. But if a given foreign bank accepts digital cash, this delay is significantly reduced [16].

Third, digital cash payments potentially can be used by anyone with access to the Internet and an Internet-based bank. While credit card payments are limited to authorized stores, digital cash makes person-to-person payments possible. Thus, even very small businesses and individuals can use digital cash for all sorts of transactions.

The consequence of these effects is an enlargement of new business opportunities and an expansion of economic activities on the Internet. Even small businesses can trade with customers all over the world. Multinational small businesses will become a dynamic new force in local and regional economies [17]. For example, a high school student may use the Internet to sell his programs to a world-wide customer base, accepting digital cash as payments for his products. Not only will individuals and small companies benefit. Large firms will find digital cash efficient for international payments leading to less expensive and more sophisticated services for most customers.

Problems

1. Taxation and money laundering

Digital cash may cause some problems in part because it permits seamless transactions across national borders. Should sales taxes be imposed on Internet transactions? Suppose a Chinese software developer uses a server in the United States to sell his software, say to a customer in Japan. Which sales tax rate should be applied, and by whom? Which country should benefit from the tax? Conflicts over international taxation of digital commerce, which have appeared only occasionally so far, could intensify. This problem may need to be resolved by a whole new view on international taxation. Since digital cash is untraceable, not leaving well-defined records for a tax authority to follow, taxation will not be easy even if there are adjustments to tax regulations [18].

The untraceability of digital cash may encourage criminal activities such as money laundering. Sending real money as digital cash means transport across national boundaries without any real evidence of transfer [19].

As mentioned earlier, not all electronic money is untraceable. Traceable electronic payments will not cause taxation and other problems, thanks to residual transaction records [20]. If digital cash in its untraceable, real cash-like form spreads in cyberspace, taxation and illegal transfers of funds will become a serious issue [21].

2. Macroeconomic effects

What are the possible effects of digital cash on large-scale, economic stability? Is digital cash a proxy for real currency or is it just privately-issued new currency?

For the sake of this analysis, I will assume that digital cash is a proxy of currency in the real world. In other words, digital cash will be issued on the same terms as existing hard currency - digital cash of dollar, digital cash of yen - and can be exchanged to its hard currency equivalent at anytime.

Some assume that since digital cash is issued by private firms, it is independent of government conditions [22]. If this assumption is correct, digital cash may have a kind of monetary freedom [23]. Nevertheless, it will be difficult for the public to trust a privately-issued currency, not controlled by the government in some fashion.

The conditions that make government-issued money credible do not apply to privately-issued currency. Government-issued currency is the official currency of a given state, and is used, in spite of its value, by the citizens of a given state. Citizens can voice their views, in some cases, of economic policy and the value of government-issued currency during elections. Overall, within a nation, there is only one official currency, and there are no alternatives. These conditions do not hold true for privately-issued currency. If the value of a specific privately-issued currency begins to depreciate, those using this currency quickly dispose of it. This dumping may accelerate the depreciation of a given currency, and, in extreme cases, eventually lead to bankruptcy. This instability may discourage the use of privately-issued currency.

If the value of digital cash is exactly equal to real currency, then digital cash is convertible to real currency at anytime [24]. For example, dollar-term digital cash would have the same unit as dollars and customers would be able to convert it to real cash. In other words, digital cash is not "new" currency in the sense that the dollar, mark, or yen are new [25]. Hence, we will assume that digital cash is cash backed (or created) by banks using real cash as a base, and that there is guaranteed convertibility to real cash. Even under these conservative assumptions, I envision several monetary problems.

2a. Macroeconomic effects: exchange rates
Digital cash may potentially increase instabilities in exchange rates. Since digital cash is a proxy for real currency, there has to be an exchange rate applied to it. There must be a foreign exchange market in cyberspace (see Figure 2).

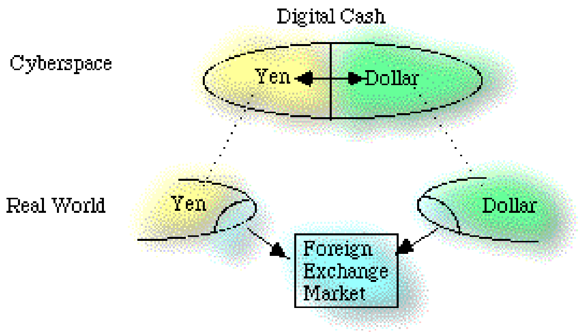


Figure 2 *In the real world, only selected people such as professional dealers, bankers, and trading firms participate in foreign exchange markets. By contrast, in cyberspace, the general public will join the exchange market because the fee of exchange is much lower and people are not confined to national borders. This massive participation may cause instability of exchange rates.*

For example, dollar-term digital cash can be exchanged for yen-term digital cash using the real world exchange rates as a base. The exchange rates in cyberspace and in the real world should be equal. If not, arbitrage transactions would immediately equalize the virtual and real exchange rates.

However, there will be differences between virtual and real exchange markets. First, the fee for exchanging one currency's digital cash with another currency's digital cash should be lower than the fee for exchanging real cash, since exchanging digital cash is merely an electronic activity. In the real world, the difference between the selling rate and the buying rate is about 2% for average customers. This rate reflects the costs of the storing the actual bills in various currencies, managing branches to handle the currencies, and hiring workers to staff the branches. Most of these costs will be eliminated with digital cash. Thus, the exchange fee for digital cash should become very small. This reduction should encourage greater participation in the foreign exchange market.

Second, users of digital cash will use the Internet to broaden geographically their consumption patterns. In turn, those with digital cash will be more likely to carry a richer variety of currencies, a variety of digital cash notes based on real currencies in different states. In the real world, a consumer will most likely have on hand cash just of one state. In the virtual world, a consumer may have stored on a hard disk digital currencies of several states for purchases. If one currency is depreciating, consumers will be more likely to exchange one form of digital cash for a more valuable and less volatile form of digital cash. In other words, there will be an incentive toward speculation in digital currencies.

If there is a great deal of digital speculation, it could lead to the de-stabilization of foreign exchange rates. Speculative behavior could accelerate the initial depreciation of any given currency and amplify general fluctuations in the market. A so-called bubble effect could occur.

Of course, an increase in the number of participants may stabilize the market, if the participants' expectations are independent of each other. But if expectations are dependent on each other, it increases the prospects for a bubble to occur [26]. Bubbles historically are a possibility when the general public joins in speculative transactions [27]. Massive participation by the general public in virtual speculation may de-stabilize the foreign exchange rate since the exchange rate of digital cash is linked to the real world.

2b. Macroeconomic effects: money supply

Digital cash may affect the money supply in the real world. Those using digital cash deposit real cash in a bank and request in exchange for this real money digital cash. If a bank issuing digital cash does not offer loans in the form of digital cash (a so-called 100% reserve system), the amount of digital cash will be fixed to the amount of the real cash on deposit. In this conservative case, no new money will be created.

However, if the economy of the Internet expands, banks may chose to lend customers money in the form of digital cash. Banks will move to a virtual, fractional reserve system parallel to that found in the real world. New money will be created. In other words, the total amount of digital cash will exceed the amount of deposited real cash (see Figure 3).

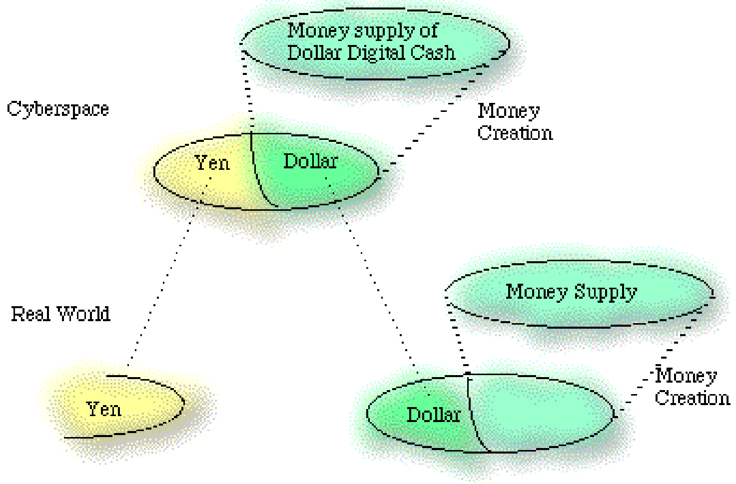


Figure 3 *When banks in cyberspace begin loans in digital cash, digital cash will exceed reserved real cash (money creation). Reflecting the fluctuation of money demand in cyberspace, cyberspace will absorb or give out real cash. This will affect the money supply in the real world. (Problem 3)*

This money creation could lead to the possibility of bankruptcy. But since there is no central bank in cyberspace, the bankruptcy of banks tend to cause chained-bankruptcy, that is, financial crisis. (Problem 4)

In turn, there will be a money multiplier of digital cash. "Money multiplier" in this case means the ratio of issued digital cash to deposited real cash, on reserve, in this cyber-economy. If the virtual economy develops like normal, real economies, this process can be expected to evolve over time.

This development means that money in cyberspace fluctuates with virtual economic activity which in turn eventually has an impact on the real world's money supply. Suppose the virtual economy expands leading to a temporary shortage of digital cash. The demand for digital cash will mean the transfer of real cash to electronic banks. Cyberspace will absorb real cash and in turn shrink the money supply in the real world.

This sort of interaction is not new. In the real world, economic expansion by one country will increase its interest rate, which will lead capital to flow in from other countries, contributing to a shortage of other money supplies elsewhere. But there are other complicating factors in cyberspace. First, since digital cash is a proxy of real cash, this interaction with money supplies will be more direct and rapid. In the real world, geography and fluctuating exchange rates dampen the speed and amount of capital flow. These barriers are minimal for digital cash. Therefore, the interaction between cyberspace and a given national economy may be more direct and rapid than that between two national economies. Second, since cyberspace is borderless with no central monetary authority, digital cash in the form of dollars can be issued by anywhere in the world. As the virtual system exists, it would be impossible for any one government authority to try to regulate the production of digital cash everywhere. These factors will make the monetary control for central banks potentially more difficult.

2c. Macroeconomic effects: financial crisis

If banks begin to create new money in the form of digital cash, there will be an opportunity for bankruptcies, the chain effect of which may easily lead to a virtual financial crisis.

A bank that issues digital cash within the limits of its real cash on deposit, and which does not lend, can respond to any and all demands of its customers for real cash. In this case, bankruptcy would be unlikely and the chain effect is limited. Nevertheless, the natural evolution of virtual finance will probably parallel the real world. Banks will loan digital cash beyond their deposits of real cash. This development may lead to bankruptcy of a given virtual bank, which in turn may cause other banks to default.

In the real world, this risk is minimized by a safety net offered by central banks or institutions in the United States such as the Federal Deposit Insurance Corporation (FDIC). In cyberspace so far, there is no central banking authority that provides the equivalent of this safety net. For example, some forms of deposits in the Mark Twain Banks are not insured by the FDIC [28].

It is possible that the default of one bank may lead to the defaults of other virtual banks. Customers may rush to their banks to demand a conversion of digital cash to real cash. If there are insufficient real funds on hand, there could be a financial crisis. In the absence of a virtual central bank, there is an increased risk for this sort of problem [29].

The problems and benefits of digital cash will not occur unless the amount of digital cash in use is equivalent to a considerable percent of world GDP [30]. What is the critical characteristic of digital cash? If we can identify this characteristic, can we predict some consequences of the use of digital cash?

3. Characteristics

What is the most important character of digital cash? One characteristic played an important role in all of the previously discussed cases: transnationality. Digital cash is not constrained by national borders. Those using digital cash can purchase services and goods from any site anywhere on the Internet. Banks issuing digital cash can do so relative to any stable, real currency.

Transnationality makes international transactions more efficient. For example, in Japan, with traditional currencies the bank commission on an international money transfer is equivalent to about 20 or 30 dollars; for a domestic transfer, the fee is roughly 2 or 3 dollars. The cost reduction for international virtual transfers of funds should be quite dramatic. As discussed earlier, the problems for digital cash are also deeply rooted in this transnationality.

To understand the importance of transnationality, let us assume that digital cash is completely domestic. That is, only a bank in a given state can issue digital cash in that state's currency. Only the citizens of that state can use this digital cash and only with merchants for products and services within the state. The benefit of digital cash will be reduced to the level of a new payment system equivalent to a new variety of credit or prepaid card. The prospect of multinational small businesses will be impossible. A potential worldwide customer base will evaporate.

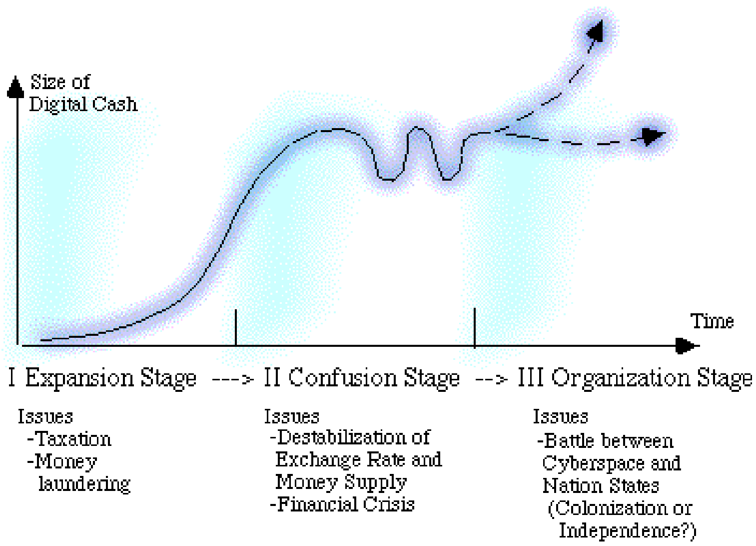
Regardless of these losses, the potential problems, caused by digital cash, will be far less serious. In this scenario, domestic taxes can be applied to electronic transactions. Money laundering may be possible, but it also will be more easily detected. With digital cash not traveling on the world's markets, there will be less incentive to participate in exchange rate speculation. Disturbance of the money supply will be minimized because a given central bank can control not only real cash but also digital cash by the conventional means. Both the benefits and problems of digital cash disappear if digital cash is completely domestic.

Transnationality is a critically important characteristic of digital cash. If digital cash was affected by the borders of states, it would be considered just an efficient payment system like a credit card or an electronic transfer. There would be no significant economic implications. Credit cards and electronic transfers increase the efficiency of financial transactions, changing the velocity of money and raising the money multiplier [31]. But credit cards and electronic transfers have not caused significant problems that are possible with digital cash. Digital cash that respected the borders of states and followed the regulations of central banking authorities would pose few negative economic consequences [32].

It's important to distinguish digital cash from so-called electronic money. Electronic money, as we know it today, is not transnational. A smart card system like Mondex is regarded by some as a form of digital cash [33]. But some smart card systems require specialized equipment, reducing their global reach [34].

4. One Possible Scenario
Some of the consequences considered in this paper will only occur if digital cash is used extensively on the Internet. There are many who are anxious about the security issues surrounding digital cash [35]. If these concerns outweigh the benefits, digital cash will not spread. In addition, in the real world there are many regulations that protect the consumer and provide for financial stability. These laws could act as obstacles for the widespread use of digital cash [36]. In spite of these potential difficulties, I would like to consider at least one scenario, in which digital cash will become prevalent on the Internet.

The widespread use of digital cash will turn cyberspace into a large-scale economy. The attendant benefits of digital cash, in this scenario, will be sufficiently plentiful to overcome security concerns. With an increased use of digital cash, what will happen? In this scenario, I will consider three stages of development.



4a. One Possible Scenario: Expansion Stage
Digital cash spreads on the Internet. Increased efficiency brings unprecedented benefits to both producers and consumers. Multinational small businesses gain momentum and new business organizations appear, the so-called virtual corporations. Consumers enjoy the ability to purchase goods and services anywhere in the world. Some banks, that decide adhere to traditional transaction systems, lose their competitive edge. The size of the cyberspace economy, measured by the total sales on the Internet or the GNP, grows at a more rapid pace than the economy of the real world.

As long as the size of the cyberspace economy is smaller than the economy of the real world, effects on exchange rates and money supplies are limited. The main problems at this stage are over-taxation and criminal activities. These two areas demand an international accommodation of rules, such as an international standard taxation rule on Internet-based transactions and an international agreement on criminal investigations [37]. The process of making these new rules may lead to harsh negotiations between different states. The new rules may be a patchwork of regulations that may not change the fundamental characteristics of digital cash [38]. It is possible that in spite of these regulations, the use of digital cash will expand.

4b. One Possible Scenario: Confusion Stage
The expansion of digital cash will eventually enlarge the cyberspace economy so that it will have a significant impact on the real international economy. For example, suppose the amount of transactions in cyberspace are 5% of the total of all international transactions. There is the possibility then of effects on the exchange rate and money supply. There will be resistance to any sort of control or reform of digital economic activity. This resistance may indeed confuse the general public, politicians, and bureaucrats. It may require the shock of a financial crisis to bring some order to virtual transactions.

4c. One Possible Scenario: Organizing Stage
If a financial crisis actually occurs, what kind of reform might be possible? There are two possibilities: territorial segmentation of cyberspace by national states or alternatively, the establishment of a monetary authority in cyberspace. In the first case, every bank on the Internet would fall under the jurisdiction of some nation and be controlled by the central bank of that specific state. The central bank, in turn, would be responsible for the control and circulation of digital cash. For example, regulations would be introduced to prohibit digital banks from "printing" digital cash in foreign currencies just to stabilize exchange rates [39]. With these sorts of controls, digital cash will lose its transnationality. This sort of reform would represent a colonization of cyberspace by nation states.

The division of cyberspace into national states obviously would not be a satisfactory solution for most netizens [40]. Another possibility would be to establish a monetary authority in cyberspace just like a central bank in the real world. The organization of this monetary authority may represent a union of the banks on the Internet, a committee of technical experts and bankers, or a group of netizens elected on a routine basis in cyberspace. However it may be founded and organized, this authority would be responsible for the financial stability of digital economics and ensure its proper links to reality. All banks issuing digital cash would have to accept the authority of this international, digital monetary bureaucracy.

However, if digital cash remains a proxy of real cash, this monetary authority will not be able to perform its role well in the absence of a right to issue real cash. In the real world, a monetary authority can issue real cash to any extent as a last resort of credit. If digital cash remains a proxy of real cash, this newly created virtual authority would not be a last resort of stability in the face of a potential crisis.

Suppose this authority could create a completely new, digital currency that we will call e$. e$ would be a new currency similar to the dollar or yen but only the virtual monetary authority could issue e$-term digital cash. Other banks on the Internet would use this cash as a base money. As a consequence, cyberspace would obtain sovereignty and monetary independence [41].

An independent agency governing virtual financial transactions is not a completely remote possibility. There are a number of suggestions that encourage the independence of cyberspace relative to reality. This independence will foster the growth of different kinds of organizations to exert some control over Internet-based activities [42]. The absence of these sort of bureaucracies and authorities may mean that the history of digital cash is really a description of one of the many battles between cyberspace and nation states.

Conclusion

Digital cash will provide benefits and problems in the near future. It is the very transnational character of digital cash that will open new business opportunities around the world but also bring vexing problems for governments. The solutions to these problems may very well lead to a more controlled cyberspace with parallel structures and regulations governing the use of funds. Alternatively, the economy of the Internet may be regulated by those who best know cyberspace, the netizens, technicians, and agents of this borderless place, in the form of new and responsive digital bureaucracy. The economic consequences of the large-scale use of digital cash clearly indicate that some form of control will occur. Only time will tell if the history of virtual commerce will be peaceful, successful, and tightly coupled with current operational features of the international financial community.

The Author

Tatsuo Tanaka Center for Global Communications, International University of Japan, 6-15-21, Roppongi, Minato-ku, Tokyo 160, Japan; telephone: +81-3-5411-6677, fax: +81-5412-7111, e-mail: tatsuo@glocom.ac.jp

Current address: Center on Japanese Economy and Business, 521 Uris Hall, Columbia University, New York, NY, 10027 USA; telephone: +1-212-854-3976, fax: +1-212-678-6958, e-mail: tatsuo@glocom.ac.jp

---

Notes

1. See, for example, Mark Bernkopf, "Electronic cash and monetary policy," First Monday, vol. 1, no. 1 (May 1996), http://www.firstmonday.org

2. See Friedrich A. von Hayek, 1976. Denationalisation of money : an analysis of the theory and practice of concurrent currencies (London : Institute of Economic Affairs), 107 p.

3. For a brief survey of electronic payment systems, see L. Jean Camp, 1995. "Opportunities, options and obstacles in electronic commerce," paper presented at Columbia Institute for Tele-Information Conference on the Future of Electronic Banking, in October 1995. For a comprehensive description of various types of electronic money, see Michael Froomkin, 1996. "Flood control on the information ocean: Living with anonymity, digital cash, and distributed databases," draft version 1.7, presented September 21, 1995 at the Conference for the Second Century of the University of Pittsburgh School of Law: The Adequacy of Current Legal Paradigms to Meet Future Challenges. To be published in a symposium volume of the University of Pittsburgh Journal of Law and Commerce, http://www.law.miami.edu/~froomkin/ocean1-7.htmAlso see Jason Solinsky, "An Introduction to electronic commerce" at http://www.worldquest.com/wqu/elecomm.htm; Michael Peirce, "Network Payment mechanisms and digital cash" at http://ganges.cs.tcd.ie/mepeirce/project.html; and, Hal Varian, "The Information economy" at http://www.sims.berkeley.edu/resources/infoecon/

4. It has been estimated that social cost of an automatic electronic clearing system was 34 cents; see Allen N. Berger and David B. Humphrey. 1986. "The Role of interstate banking in the diffusion of electronic payments technology," In: Technological innovation, regulation, and the monetary economy. Colin Lawrence and Robert P. Shay (eds.), Cambridge, Mass.: Ballinger, pp.13-52. Therefore, micro-payments are impossible. In the United States, an average credit card transaction was approximately $20 to $40 in the late 1970s; see Ralph C. Kimball, 1980. "Wire transfer and the demand for money," New England Economic Review (March/April), pp. 5-22. It is now thought to be $60.

5. Electronic money has many other features which have to be considered such as non-refutability, divisibility, time limits, and portability. For further details, see XIWT Cross-Industry Working Team, "Electronic cash, tokens and payments in the National Information Infrastructure," http://merlin.cnri.reston.va.us:3000/XIWT/documents/dig_cash_doc/ElecCashToC.html

6. See the First Virtual home page at http://www.fv.com

7. It has been estimated that the cost of check clearance is 68 cents, which is

greater than the cost of automatic electronic clearance at 34 cents. Hence, it has been estimated that the users of checks receive an average subsidy of 15 cents per check. See Allen N. Berger and David B. Humphrey. 1986. "The Role of interstate banking in the diffusion of electronic payments technology," In: Technological innovation, regulation, and the monetary economy. Colin Lawrence and Robert P. Shay (eds.), Cambridge, Mass.: Ballinger, pp.13-52. Checking in the real world is not suitable to micro-payments. But electronic checks on the Internet may reduce operational costs significantly.

8. See the CyberCash home page at http://www.cybercash.com and NetCheque at http://gost.isi.edu/info/NetCheque/

9. See Stephen Crocker, Brian Boesch, Alden Hart, and James Lum, "CyberCash: payment systems for the Internet," http://info.isoc.org/HMP/PAPER/181/abst.html

10. Chaum and other digital cash proponents stress untraceability and anonymity thoroughly. See, for example, David Chaum, 1987. "Security without identification: Card computers to make big brother obsolete," http://www.digicash.com/publish/bigbro.html, originally appeared in the Communications of the ACM, vol. 28, no. 10 (October 1985), pp. 1030-1044. These issues have also been treated extensively by the cypherpunks. On the cypherpunks' strong commitment to anonymity, see Timothy C. May, 1994. "Digital cash and net commerce," http://ocaxp1.cc.oberlin.edu/~brchkind/cyphernomicon/12.html and also Eric Hughes, 1993. "A Cypherpunk's manifesto," http://weber.u.washington.edu/~phantom/cpunk/cpunk.manifesto

11. Chaum established his company, DigiCash, and started an experimental system in 1994 (see http://www.digicash.com). Digicash's system has been realized with the establishment of the Mark Twain Banks, operating since the end of 1995. See David Chaum, 1989. "Online cash checks," Advances in Cryptology - EUROCRYPT '89, pp. 288-293, http://www.digicash.com/publish/online.html and David Chaum, 1992. "Achieving electronic privacy," Scientific American, (August), pp. 96-101, http://www.digicash.com/publish/sciam.html

Okamoto and Ohta's system was implemented by NTT and is scheduled to be used experimentally sometime in 1996. See Tatsuaki Okamoto and Kazuo Ohta, 1991. "Universal electronic cash," Advances in Cryptgraphy-Crypto91, Lecture Notes in Computer Science, vol. 576, pp. 324-337.

12. Visit Mark Twain Banks at http://www.marktwain.com/

13. If the cost of connecting the Internet and personal computers is taken into account, the cost of electronic cash is high. But with the recent explosion of the Internet and its attraction to businesses, banks, and individuals, the actual cost of electronic cash transfers will be recognized as negligibly small. To put this

another way, the cost of the personal computer and its Internet connections will be seen as a "sunk cost."

Another point is that when many banks begin to issue their digital cash, there will appear a different cost, the cost of inter-bank transfer of real cash. Let assume that Alice and Bob use different banks. Assume Alice sends one digital cash dollar to Bob, and Bob brings it to his bank. Bob's bank communicates with Alice's bank and raises his account by one dollar. Now Bob's bank holds digital cash issued by Alice's bank. If Bob's bank does not claim to exchange that digital cash with real cash, there is no need to use the expensive normal banking network to transfer one real dollar. But eventually Bob's bank may want to exchange it with real cash for some reason. If so, Bob's bank have to use the traditional expensive banking network and this transaction will have some cost.

If many banks begin to issue digital cash, there may be a convertibility problem among various forms of digital cash. For further details on convertibility, see Mauro Cipparone, 1996. "Digicash convertibility - a look into the future." Journal of Internet Banking and Commerce, vol. 1, no. 1 (January), http://www.arraydev.com:80/commerce/JIBC/9601-5.htm and David S. Bennahum, 1995. "The trouble with E-cash," Marketing Computers, vol. 15, no. 4 (April). p. 25, http://www.reach.com/matrix/troublewithecash.html

14. In the case of the Mark Twain Banks, however, it imposes 4% to 5% fee when you change digital cash to real cash. This fee is high especially for shops who have to pay their operational costs with real cash. This exit cost is expected drop in the near future.

15. On superdistribution, see Ryoichi Mori and Masaji Kawahara, 1990. "Superdistribution: The Concept and the architecture," Transactions of the IEICE, vol. E73, no. 7 (July), http://www.virtualschool.edu/mon/ElectronicProperty/MoriSuperdist.html and Brad Cox, 1994. "Superdistribution", Wired, Issue 2.09 (September), http://www.hotwired.com/wired/2.09/departments/idees.fortes/superdis.html

16. Of course, a foreign bank may not accept digital cash. It may also demand extra fee for accepting it because of the "convertibility" problem. See Mauro Cipparone, 1996. "Digicash convertibility - a look into the future." Journal of Internet Banking and Commerce, vol. 1, no. 1 (January 1996), http://www.arraydev.com:80/commerce/JIBC/9601-5.html

17. Nick Szabo, 1993. "Multinational small business," http://www.digicash.com/~nick/multi.small.html

18. Conventional sales taxes are based on the actual geographical location of merchants and customers. In the United States, sales tax rates vary from state to state. American tax authorities are examining this issue critically, as a new source of tax revenues. See Catherine Yang, 1996. "New Tolls on the info highway : States see big revenues in cyberspace," Business Week (February 12),

pp. 96-97.

19. Regarding money laundering and digital cash, see Anonymous, "Electronic money: So much for the cashless society," Economist, vol. 333 no. 7891 (November 24), pp. 23-27, and Sarah Jane Hughes, 1995. "Cyberlaundering," http://w3.win-uk.net/cybercon/art_0795/launder.htm

If digital cash is completely traceable, money laundering and tax invasion would become almost impossible. It is important to note that strong traceability is not realized even for current, conventional currencies and monetary systems. Although traceable digital cash would be welcomed by government authorities, the loss of privacy would be upsetting to many. Regarding this confrontation between anonymity and money laundering, see Robert Hettinga, 1996. "Internet banking & commerce: Security," Journal of Internet Banking and Commerce, vol. 1, no. 1 (January), http://www.arraydev.com:80/commerce/JIBC/9601-2.htm

20. Michael Froomkin proposes that full anonymous digital cash should be discouraged or banned because of its crime usage. See Michael Froomkin, 1996. "Flood control on the information ocean: Living With anonymity, digital cash, and distributed databases," draft version 1.7, presented September 21, 1995 at the Conference for the Second Century of the University of Pittsburgh School of Law: The Adequacy of Current Legal Paradigms to Meet Future Challenges. To be published in a symposium volume of the University of Pittsburgh Journal of Law and Commerce, http://www.law.miami.edu/~froomkin/ocean1-7.htm and Michael Froomkin, 1996. "The Internet as a source of regulatory arbitrage," presented at the Symposium on Information, National Policies, and International Infrastructure, January 29, 1996, http://www.law.miami.edu/~froomkin/arbitr.htm

21. The American Bankers Association is reluctant to adopt full anonymity because of criminal usage such as money laundering, kidnapping and extortion. See Steven Levy, 1994. "E-Money (that's what I want)," Wired, Issue 2.12 (December), http://www.hotwired.com/wired/2.12/features/emoney.html It has been reported that CyberCash Inc. chose not to provide anonymity in light of the potential for criminal activity.

On the other hand, DigiCash Inc. argues that untraceable digital cash does not cause serious tax evasion or encourage criminal activities. Because all digital cash must be given to a bank for confirmation, and because any customer can prove that a certain payment was made, DigiCash thinks that these problems are not significant. See DigiCash, Inc, "Ecash and crime," at http://www.digicash.com/ecash/aboutcrime.html

22. Jon Matonis, 1995. "Digital cash & monetary freedom," Proceedings of INET'95, June 27-30, 1995 at Hawaii, http://info.isoc.org/HMP/PAPER/136/html/paper.html

23. For more on this sort of monetary freedom, see Friedrich A. von Hayek, 1976. Denationalisation of money : an analysis of the theory and practice of

concurrent currencies (London: Institute of Economic Affairs), 107 p.

24. Under this assumption, a 100% reserve system and a fractional reserve system are possible. In the latter case, digital cash will be created beyond the deposited real cash, just as in conventional systems.

25. If digital cash is a new currency equivalent to the dollar and yen, it should have its own unit (cyber-dollar or e-dollar). Convertibility to other currency would not be guaranteed by issuing banks but performed in the foreign exchange market. In other words, the exchange rates between digital cash and real cash would vary from time to time in the market just like exchange rates among real currencies. Since digital cash is not a proxy of real cash, electronic cash will be issued without backup reserves of real cash.

26. See, for example, Peter Rappoport and Eugene N. White, 1994. The New York stock market in the 1920s and 1930s : did stock prices move together too much? (Cambridge, Mass.: National Bureau of Economic Research), NBER working paper no. 4627, 21 p.

27. On the most famous bubble of this century, see Frederick L. Allen, 1931. Only Yesterday: an Informal History of the Nineteen-Twenties. New York: Harper & Brothers, 370 p., and John K. Galbraith, 1955. The Great Crash, 1929. Boston: Houghton Mifflin, 212 p.

Exchange rate volatility is said to have increased after the liberalization of international capital markets; see, for example, Giancarlo Corsetti, Vittorio Grilli, and Nouriel Roubini, 1990. Exchange rate volatility in integrating capital markets. (Cambridge, Mass.: National Bureau of Economic Research), NBER working paper no. 3570, 23 p.

28. "When you instruct Mark Twain to transfer money to the Ecash system, the Bank moves the funds to the Ecash Mint. While there are plans to do this in real time, the transfers will be done once a day for now. Once a withdrawal has been made from the WorldCurrency Access account [editor’s note: this account is insured by the FDIC] your money is no longer on deposit at Mark Twain Bank and is no longer insured by the FDIC." See http://www.marktwain.com/money.html

29. "Perhaps I was overly indoctrinated during the 6 years I spent working at the Federal Reserve, but I believe that banking is inherently fragile and requires careful regulation. Absent any regulation, banks have the power to issue notes that are not backed by assets. They have the power to accept deposits and then invest the money unwisely or divert it to the banker’s personal use. These powers are inherent in any company that performs banking functions. This will be as true of the banks and funds transfer services sprouting up on the Net as it is true in traditional finance.

If banking on the Net takes place in an entrepreneurial, unregulated environment, then I predict that within 12 months we will see a bank failure of traumatic proportions. Some bank somewhere on the Net will not have enough real-world cash reserves to redeem its notes or to cash out its depositors. This will lead to a loss of confidence and "runs" on every bank on the Net. Commerce based on entrepreneurial banking will come to a halt.

To avoid this scenario, somehow we have to integrate the innovative technology of the Net with traditional (or enhanced) mechanisms that promote safety and soundness. The technology without the regulation strikes me as too risky."

From Arnold Kling, 1996. "Banking on the Internet," at http://www-e1c.gnn.com/gnn/meta/finance/feat/archives.focus/bank.body.html

30. There are several crude forecasts indicating an explosion of electronic payments. One report stated that consumers will spend as much as 10% of their total expenditures in the form of electronic cash by the end of the century; from Anonymous, 1995. "The Future of money: E-cash could transform the worlds' financial life," Business Week (June 12), pp. 36-46.

31. The introduction of electronic funds transfer system (EFT or wire transfer) permitted new cash management services such as security repurchase agreements and cash concentration accounts. These new services let corporations retain much less cash leading to a decline for money. Some insist these financial innovations were responsible for the decline of the money aggregate in the late 1970s in the United States; see, for example, John P. Judd and John L. Scadding, 1982. "The Search for a stable money demand function: A Survey of the post-1973 literature," Journal of Economic Literature, vol. 20 (September), pp. 993-1023, and Ralph C. Kimball, 1980. "Wire transfer and the demand for money," New England Economic Review (March/April), pp. 5-22.

32. There were several arguments on the effect of electronic fund transfer during 1970s and 1980s. The focus of those arguments dealt with consumer protection, management, and regulation. For example, see Arthur D. Little, Inc., 1975. The Consequences of electronic funds transfer : A Technology assessment of movement toward a less cash/less check society. Washington, D. C., National Science Foundation, 351 p., and Electronic funds transfer: plastic cards and the consumer. Paris: Organisation for Economic Co-operation and Development, 1989, 136 p. There have been discussions of the impacts of EFT on macro-economics from Keynsian and monetarist points of view; see James Tobin, 1987. "Monetary rules and control in the brave new world," In: Electronic funds transfers and payments: the public policy issues (Elinor Harris Solomon, ed.). Boston, Kluwer-Nijhoff, pp. 137-158, and Thomas Havrilesky, 1987. "Monetary modeling in a world of financial innovation," In: Electronic funds transfers and payments: the public policy issues (Elinor Harris Solomon, ed.). Boston, Kluwer-Nijhoff, pp. 159-188. While there are disagreements on the role of monetary policy, all seem to agree that EFT has had no substantial impact on conventional monetary policy.

33. "Mondex is electronic cash on a card.

Instant cash is the preferred method of payment around the world, accounting for 90 per cent of all transactions. Now smart cards - storing electronic cash on an encrypted microchip - are set to revolutionise spending habits.

Mondex uses a smart card to store electronic cash, which can be used to pay for goods and services in the same way as cash, but with some key benefits over traditional cash. Mondex has an electronic locking system, which makes it more secure than cash. Because it is electronic, Mondex value can be sent and received instantly across phone and computer lines, making it an ideal vehicle for paying for goods and services on the internet. As with cash, Mondex payment transactions do not need authorisations or signature and just like cash Mondex value can be moved directly between individuals."

From "Mondex at a glance," at http://www.mondex.com/mondex/glance.htm

34. Smart card systems do not necessarily contradict digital cash because both systems use the same protocols. This convergence may be useful because smart cards are much more mobile than even the most portable computers.

35. A recent survey of 204 respondents on the Internet indicated that over half would use electronic cash but only if it was secure. The sample was not random but based on visitors to a specific questionnaire on the Web; see Roy Weiler, "Internet money survey," http://graph.ms.ic.ac.uk/money

36. See, for example, Melanie L. Fein, 1995. "Regulating cyberspace: What does it mean to banking?" Bank Management (September/October), http://www.bai.org/Magazine/RegCyber.htm

37. On the sale tax, there is a growing discussion in the United States on differential sales tax rates between different states. Software for locating customers is expected to help the enforcement of the rule. See Catherine Yang, 1996. "New tolls on the info highway: States see big revenues in cyberspace," Business Week (February 12), pp. 96-97.

38. The strongest regulation would be a ban on fully anonymous digital cash; see Michael Froomkin, 1996. "Flood control on the information ocean: Living with anonymity, digital cash, and distributed databases," draft version 1.7, presented September 21, 1995 at the Conference for the Second Century of the University of Pittsburgh School of Law: The Adequacy of Current Legal Paradigms to Meet Future Challenges. To be published in a symposium volume of the University of Pittsburgh Journal of Law and Commerce, http://www.law.miami.edu/~froomkin/ocean1-7.htm

Although regulations may reduce the benefits of digital cash to a considerable extent, taxation and criminal investigation will become far more easier. In reality, to provide for anonymity, "almost" anonymous digital cash may be proposed.

"Almost anonymous" means that banks mainly issue untraceable digital cash, but only under specific conditions. For example, banks could issue traceable digital cash under the proper demand of a tax authority, a police force, or court order. For further details on "almost anonymous" digital cash, see XIWT Cross-Industry Working Team, "Electronic cash, tokens and payments in the National Information Infrastructure," http://merlin.cnri.reston.va.us:3000/XIWT/documents/dig_cash_doc/ElecCashToC.html

Perhaps the weakest regulatory solution would be only international cooperation on a few aspects of digital cash, such as taxation and crime, without a reduction in the anonymity of digital cash. As noted earlier, DigiCash Inc. does not see a problem with untraceable digital cash. See DigiCash, Inc, "Ecash and crime," at http://www.digicash.com/ecash/aboutcrime.html

39. Some anticipate that government will not allow digital cash to bypass regulated conventional foreign-exchange markets; see Anonymous, 1994. "Electronic money: So much for the cashless society," Economist, vol. 333, no. 7891 (November 24), pp. 23-27.

40. On netizens, see Michael Hauben, 1995. "Netizens: On the history and impact of Usenet and the Internet," http://www.columbia.edu/~hauben/project_book.html

41. Creating new money in cyberspace may sound strange. But there are analogs in the real world: the ECU (European Currency Unit) of the European Union and the SDR (Special Drawing Right) of the International Monetary Fund. The idea of a transnational currency has a long history; see, for example, the proposal for a Supernational Credit Money to stabilize the international monetary system in Robert Guttmann, 1994. How Credit money shapes the economy: The United States in the global system. Armonk, N. Y., Sharpe, 561 p. A new cyberspace currency represents an evolutionary path for digital cash; see Anonymous, 1994. "Electronic money: So much for the cashless society," Economist, vol. 333, no. 7891 (November 24), pp. 23-27.

42. John Barlow, one of the founders of Electronic Frontier Foundation, recently circulated a declaration on the independence of cyberspace to action by the United States Congress to exert some legal control over the Internet; see http://www.eff.org/pub/Publications/John_Perry_Barlow/barlow_0296.declaration Though Barlow is concerned with freedom from government censorship, this declaration could be interpreted as a foundation for independent, Internet-based controls rather than those founded on legal structures of specific states.
