# ELECTRONIC MONEY

# IN THE EVOLUTION OF OUR PAYMENTS MECHANISM

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**ABSTRACT**

Electronic money (EFTS), is progressively replacing cash and checks in industrialized economies. This paper analyzes the main forces behind this need for change by utilizing the standard concepts of equilibrium and efficiency in a static resource allocation framework. It then analyzes transaction costs in relation to time budgets and develops a dynamic analysis of the demand for EFTS to prove the existence of its self-sustaining growth process. The growth process in the EFTS demand can be explained jointly by the distribution of incomes and the cumulative public good property inherent in EFTS accounts.

## INTRODUCTION

A decade ago, we experienced a proliferation of writings dominated by representatives from financial institutions (Egner, 1991; Harris-Solomon, 1991; Humphrey, 1990; Mookerjee and Cash, 1990; Steiner and Teixeira, 1990) which indicated that electronic money, in the form of Electronic Funds Transfer System (EFTS), was progressively replacing cash and checks in advanced industrialized economies. This trend persists. The objective of this paper is to present an alternative approach in our understanding of the main forces behind this need for change.

Efficiency considerations have constituted the major driving force in the historical evolution of our payments mechanism. If the Electronic Funds Transfer System (EFTS) is ultimately an efficient payments mechanism, it will become, sooner or later, an inseparable part of our life[1]. Efficiency considerations will determine the final impact of the EFTS on the financial institutions, the households, the firms, the financial information availability, the instruments and the channels of influence of monetary policy. Efficiency considerations are expected to change society's expenditure patterns which in turn will affect the money multiplier, the monetary aggregates, the objectives of monetary policy and the ability of the Federal Reserve to control money supply.

This paper attempts to identify and analyze the place of electronic money in the ongoing change of our payments mechanism. It does that by utilizing the standard concepts of equilibrium and efficiency. The property of access/no access, or active participation vs. no participation at all in the electronic payments mechanism plays a central role in this analysis.

The first part of the paper attempts to handle the fundamental discreetness which is associated with this property in a static resource allocation framework. Then it looks at the concept of transaction costs in relation to

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[1] The conventional payments system in the USA today consists of the following payment instruments with approximate total volume of transactions in millions and total value of transactions in trillion dollars in parentheses: Cash (278,600 / $1.4), checks (47,000 / $55.8), credit cards (5,111 / $0.317), travelers checks (1,354 / $0.047), and money orders (811 / $0.07). Electronic payments used the following payment instruments with total volume of transactions in millions and total value of transactions in trillion dollars in parentheses: Automated Clearing House -ACH- operations (936 / $3.6), Wire Transfers (84 / $281.0), Point of Sale -POS- transactions (55 / $0.000822), and Automatic Teller Machine -ATM- bill payments (29 / $0.002). The USA payments system, as it now exists, costs almost $60 billion annually to operate. Shifting from checks to electronic payments could potentially save an estimated $17.4 billion.

time budgets and derives economic interpretations for the results. A dynamic analysis of the demand for EFT services is then developed to prove, by induction, the existence of a self-sustaining growth process in the EFTS demand.

**MODELING RESOURCE ALLOCATION**

**IN THE ELECTRONIC FUNDS TRANSFER SYSTEM**

Assume that there is a national market available for the EFTS consisting of 6 individuals. These 6 individuals can be considered as a market in the sense that they all enjoy transacting with each other at the most efficient way. Assume, also, that each individual has some form of (direct of indirect through taxes) transaction with every other individual, over a period of time, either by way of EFTS of through a hand to hand and therefore a face-to-face contact. Further assume that an EFTS transaction is a perfect substitute for a hand-to-hand transaction. Since EFTS will not be, at least for the near future, the only payments system available, it will be realistic to assume that in the national market we have two subsets of individuals. One, called $\ni_1$, consisting of all individuals who have access to the system by maintaining an EFTS account, and the other, called $\ni_2$, consisting of all individuals who do not have access because they do not maintain an EFTS account. The subsets $\ni_1$ and $\ni_2$ are mutually exclusive, and such that they jointly exhaust the total number of individuals in the population 6.

With these assumptions, we can now model each individual's preference or utility function. We do that by introducing electronic money and ordinary goods and services in the same utility function (e.g., Samuelson and Sato, 1984), as:

$$U^i \; [ X^i, Y^i ] \qquad (1)$$

$$X^i = X \text{ for all } i \text{ in } \ni_1$$

$$X^i = 0 \text{ for all } i \text{ in } \ni_2$$

where $U^i$ stands for the ith individual's utility function, $X^i$ stands for the ith individual's access to the EFTS (denoted by X) or no access (denoted by zero), and $Y^i$ denotes the ith individual's consumption of all other goods and services, offered in the national market.

This property of access or no access to the System can also be symbolized through the use of dummy variables $*^i$, with $*^i$=1 for an individual who has access and with $*_i$=0 for an individual who does not have access. So, an alternative formulation of the preference functions is:

$$U^i [ *^i X^i, Y^i ] \tag{2}$$

$$X^i = X \text{ for all } i$$

$$*^i = 1 \text{ for } i \text{ in } \ni_1$$

$$*^i = O \text{ for } i \text{ in } \ni_2$$

The concept of preference function used here differs from the standard form where all individuals have access to a certain public good[2], and thus we are able to incorporate into our analysis the coexistence of more than one payments mechanisms. To simplify the analysis I further assume that all individuals connected by the EFTS (I can call them "members of the electronic transactions club") consume identical bundles of goods, and similarly the individuals who do not have access to the EFTS are assumed to be all alike in the sense of having identical bundles of goods. The purpose of this assumption is to enable us to say that each individual with access to the EFTS has a utility function $U^1$, and each individual without an active EFTS account has a utility function $U^o$. Although $U^1$ and $U^o$ are the same functions, they differ in the argument values (the bundles of goods differ between them). Thus each individual in the national market has a utility function with the arguments consisting of EFTS services (or the lack of it) and all other goods and services, as stated in (1) and (2) above.

My next step is to employ Paul Samuelson's omniscient planner. I equip him with a Social Welfare Function, in order to embrace the well-being of all the 6 individuals in the population. To make precise the technological constraint imposed on the group of 6, I also provide him with a Social Production Possibility Frontier. Under this set up, I can now pose an interesting question, neatly embedded in a General Equilibrium framework. The question is: *What is the optimal number of active EFTS accounts, which could be considered as sufficient to support an efficient EFTS?* With appropriately specified and well-behaved functions, I might indeed come up with such a number. But even if I do not, the exercise could still be rated a success provided that it would shed enough light on the properties of having access to the EFTS.

At this point I formulate the optimization problem. I wish to maximize a welfare function W, in which the individuals' preference functions enter as arguments, subject to a constraint M, which is a Product Transformation Function. In symbols we have:

Max $W\{ [U_1^{\,1}],[U_2^{\,1}],...,[U6^1],[U_1^{\,0}],...,[U6^0]\}$
with respect to $Y^1$, $Y^o$, X, and where $[U_i^{\,1}] = U[Y^1,X]$, and $[U_i^{\,0} = U[Y^0,0]$
subject to: $M\ [ Y, X ] = 0$

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2 I assume that the EFTS possesses the essential property of a public good as this concept is well defined in Sumuelson 1954 and 1969.

where $Y = \Gamma Y^1 + EY^o$.

As before, X stands for production and consumption of EFTS services, and Y stands for the quantity produced and consumed of all other goods and services.

Suppose now that we measure X by the number of active EFTS accounts, or by the number of EFTS ID cards issued to facilitate EFTS transactions. If we assume that each individual is allowed to apply for only one active EFTS account, and use only one EFTS ID card, then out of the potential group membership of 6 individuals, X individuals are connected among themselves by EFTS facilities and therefore have access, and the remaining (6-X) individuals have no access to the system.

We can then state the optimization problem as:

$$\text{Max } W = W [X\, U^1, (6\text{-}X)\, U^o ] \quad (3)$$

with respect to $Y^1, Y^0$, X, subject to:

$$M [ X\, Y + (6\text{-}X)Y^0, X ] = 0 \quad (4)$$

Assuming that an interior solution exists [1<X<6], we can derive the necessary conditions for an optimum through the Lagrangian function:

$$\text{Max } L = W - 8M \quad (5)$$

with respect to $Y^1$, $Y^2$, X, 8

$$(ML/MY^1) = W_1\, XU_{\{Y^1\}} - 8\, M_Y\, X = 0 \quad (6)$$

$$(ML/MY^0) = W_0 (6\text{-}X)\ \{U_{\{Y^0\}} - 8\, M_Y\, (6\text{-}X)\} = 0 \quad (6a)$$

$$(ML/MX) = W_1 (U^1 + X\ \{U_{\{X^1\}}) - W_0\, U^0 - 8\, [dM/dX]\} = 0 \quad (6b)$$

$(ML/M8) = M = 0$ , which is the same as (4)

From (6) and (6a) we find the following optimality condition:

$$W_1\, U_Y{}^1 = W_o\, U_Y{}^o \quad (7)$$

In words, the last unit of consumer goods and services gives the same welfare, as measured by the group welfare index, no matter to which individual it is allocated.

Using all these relations (6), (6a), and (6b), we obtain the following condition:

$$[U^1/U_Y^1 - U^0/U_Y^0] + X[U_X^1/U_Y^1] = (Y^1 - Y^0) + [M_X/M_Y] \qquad (7a)$$

The relation (7a) can be interpreted as follows:

The last term on the right hand side $[M_X/M_Y]$ is the usual marginal rate of transformation (MRT). In our case it measures the marginal quantity of Y (goods and services) which must be given up, in order for the economy to produce and service one more active EFTS account.

The last term on the left hand side $X[U_X^1/U_Y^1]$ states the marginal rate of substitution between EFTS services and other goods and services (MRS). As is seen, this MRS is multiplied by X, the number of individuals who have access to the EFTS. Thus, the interpretation to be given to this term is that of a public good. For the EFTS ID card holder, access to the EFTS is a public good[3].

Some difficulty arises with the two bracketed terms, one on the left hand side $[U^1/U_Y^1 - U^0/U_Y^0]$, and one on the right hand side $(Y^1 - Y^0)$. Although the formulation of the problem that I have chosen enables us to use calculus in the optimization procedure, and thus to handle the discreetness, or [0,1] property of access/no access, the discrete nature of the problem does show up in these two terms.

To begin with the bracketed term on the right hand side, as a marginal individual joins the club (enters the EFTS), he will give up a quantity $Y^0$ and gain a quantity $Y^1$. The difference between the two, if positive, must be produced, and if negative helps to reduce the marginal rate of transformation.

Analogously, the bracketed term on the left hand side shows the net difference in total welfare obtained by having the marginal individual switch from the basket $[Y^0, 0]$ to the basket $[Y^1, X]$. Since all terms in this condition are expressed in units of Y, both $U^1$ and $U^0$ in this bracketed term are weighted by the respective marginal utility of Y.

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[3] Switching from conventional to electronic payments requires access to the EFTS by both the payer and the payee. Switching requires a mutual decision by the payer and the payee to share the EFTS benefits. In that sense, access to the EFTS is, for the EFTS ID card holder, a public good. The EFTS ID card holder's decision to join the EFTS is not like a decision to purchase an air conditioner where the usefulness of the product is not influenced by the decision of other friends and neighbors to purchase the same product.

## THE TRANSACTION FUNCTION

## AND THE PAYMENTS MECHANISM

Introducing additional constraints can extend the above model. For this purpose I search for additional parameters in the transaction function.

To establish a transaction between two or more parties, usually we have to move people, we have to use the transportation systems to bring them together, or we have to move financial information in physical packages (package the check -the financial information- in letters, and move the package from one party to the other) using the transportation system. With the technology of an EFTS we can save the transportation cost by transmitting electronically the financial information. Instead of moving people and packages we will be moving electronic information by electronic impulses. Thus, there are energy, human resources, and environmental considerations that are motivating the development of the EFTS mechanism. Electronic money is a method of financial communication which considerably conserves other economic resources, including human time. This fact enables us to extend the original model as follows:

### The Human Time Constraint

Assume that every individual (no matter whether he has an active EFTS account or not) spends an average of $\Delta$ hours (per unit time period) walking, or driving, or writing and mailing checks to each individual who cannot be reached by the EFTS. Thus, each individual in $\ni_o$ (the group of individuals without access to the EFTS), spends (6-1)$\Delta$ hours on the road in order to have a hand-to-hand transaction with other individuals or to mail a check to them. Similarly, the X individuals in group $\ni_1$ who do have access to the EFTS must each spend a total of (6-X)$\Delta$ hours getting in touch with the individuals who do not have an EFTS account.

To begin with, I assume that all other time that an individual has available (working time being fixed) can be enjoyed and therefore enters the utility function. Thus, to my previous formulation, I now add the following two time-budget constraints:

$$\forall - t^0 - (6-1)\Delta = 0, \text{ for all individuals in } \ni_o \qquad (8)$$

$$\forall - t^1 - (6-X)\Delta = 0, \text{ for all individuals in } \ni^1 \qquad (9)$$

Here $\forall$ denotes the total time available per individual, and $t^i$, i=0,1, denotes the enjoyable time per individual respectively, without or with access to the EFTS.

As above, I set out to maximize:

$W = W\,[XU^1, (6 - X)U^0]$

where I now have:

$U^1 = U\,[Y^1, X, t^1]$, for all individuals in $\ni_1$, and

$U^0 = U\,[Y^0, 0, t^0]$, for all individuals in $\ni_0$, and

where the optimization is now subject to three constraints, namely (4), (8), and (9).

The Lagrangian becomes:

$$\text{Max. } L = W[XU^1,(6-X)\,U^0] - 8M - \Phi^0[\forall - t^0 - (6-1)\Delta] - \Phi^1[\forall - t^1 - (6-X)\Delta] \qquad (10)$$

with respect to $Y^0$, $Y^1$, $t^1$, X, 8, $\Phi^0$, $\Phi^1$.

From the necessary conditions for an optimum I once again obtain the optimality condition (7) above. However, the condition (7a) will now have one more term:

$$[U^1/U_Y{}^1 - U^0/U_Y{}^0] + X[U_X{}^1/U_Y{}^1] + \Delta X[U_t{}^1/U_Y{}^1] = [Y^1 - Y^0] + M_X/M_Y \qquad (11)$$

Here, the last term on the left-hand side is new, in comparison with the previously obtained condition (7a). The interpretation of this new term can be made as follows.

As the marginal EFTS account is joining the system, each individual in $\ni_1$ saves time by not having to walk or drive any longer to the new EFTS participant. Since there are X members in $\ni_1$, the total time-savings is found by summation over all X, and the thus gained time is evaluated by the marginal rate of substitution $[U_t{}^1/U_Y{}^1]$. In this way, two terms in the condition (11) bring out the public-good property of EFTS service, both terms being summations over marginal rates of substitution. One term relates to potential access and the other to effective savings in transactions costs.

One more extension of the model can now easily be made, namely through the explicit consideration of working time as a variable.

Assuming that everyone of the X individuals in $\ni_1$ (with access to the EFTS) spends $T^1$ hours at work, and that each one of the (6-X) individuals in $\ni_0$ spends $T^0$ hours at work, we have the definitional relation:

$$T = XT^1 + (6 - X)\,T^0 \qquad 12)$$

where T denotes the total amount of time spent at work by all the 6 individuals.

Through appropriate insertions of these variables into the transformation function M and into the two time-budget constraints, I can again set out to maximize welfare, and this time (as usual assuming that a solution exists for (1<X<6) I find two optimality conditions:

$$W_1 U_Y^1 = W_0 U_Y^0 \tag{7}$$

and

$$W_1 U_t^1 = W_0 U_t^0 \tag{13}$$

From these I derive a standard efficiency result for private goods:

$$U_Y^1 / U_t^1 = U_Y^0 / U_t^0 \tag{14}$$

in the condition corresponding to (11) we get:

$$[U^1/U_Y^1 - U^0/U_Y^0]+X(U_X^1/U_Y^1)+X\Delta(U_t^1/U_Y^1 =$$

$$[Y^1-Y^0]+(M_X/M_Y)+[T^1 - T^0](M_T/M_Y \tag{15}$$

The only difference between (15) and (11) is the last term appearing on the right-hand side in (15) $[T^1 - T^0](M_T/M_Y)$. This term can be interpreted as a marginal shift in the transformation curve resulting from the change in the working time of the marginal individual who becomes an EFTS participant.

From the necessary conditions for equilibrium in this scenario, I can also derive the following relationship:

$$- [M_T / M_Y] = [U_t^1 / U_Y^1] \tag{16}$$

In (15) the savings in transaction costs (indicated by the last term on the left-hand side) show up as a welfare gain accruing to individuals in the subset $\ni_1$. Alternatively, using (16) to substitute for $[U_t^1 / U_Y^1]$ in (15) one can have these time-savings converted into more production of Y.

To summarize, by using

1) the production possibility frontier, M;

2) the two time-budget constraints for each individual in $\ni_0$ and $\ni_1$ respectively; and

3) the four relations (7), (13), (15) and (16)

I have a system of seven independent equations. With the appropriate curvature assumptions (that the production possibility set is convex and that the welfare objective function is concave), these seven equations provide us with a solution in the seven variables $Y^1$, $Y^0$, $t^1$, $t^0$, $T^1$, $T^0$, and X.

Thus, my scheme provides the omniscient planner with a calculation to confirm the optimal number of EFTS accounts, or ID cards in the system. This optimal point is also an efficient point. More important in the context of the present paper, my findings reveal that having access to the EFTS is a public good, and further that new entrants to the system provide gains to society (in the form of savings in transaction costs), which are similarly public-good flavored.

## PRICING IN AN EFTS

To bring out the essence of the static resource allocation problem involving EFTS service, I have here proceeded along the old Samuelsonian lines. The necessary conditions for equilibrium have been derived without reference to any particular form of economic organization, such as perfect competition. There are no prices or incomes appearing explicitly in my problem formulation, as they appear in Samuelson and Sato (1984). It is, of course, a question of great interest and significance whether some such "signalling system" as contained in perfect competition or in decentralized perfect planning would sustain a configuration of resource allocation comparable to the results above -comparable in the sense of also being efficient.

Appropriate pricing of the EFTS services serves the traditional role of insuring an efficient allocation of resources. To this respect, I can set up two scenarios. First assume that EFTS is owned by the private sector (e.g. private banks) which allows for profit maximizing pricing policy, and second, assume that the EFTS is owned by the Fed or another public organization which adopts a community welfare maximizing pricing behavior. Both assumptions would approximate reality since policy recommendations suggest a flexible environment that will permit both public and private participation.

In order for me to investigate this problem, I must concentrate originally on the private sector and consider in some detail and specification the optimizing behavior of micro-units, firms and households.

Assuming that all individuals have identical utility functions, possess identical endowments, and are faced by the same prices, my conjecture is that a pseudo-laissez-faire framework (to use Samuelson's words) would lead to an allocation of $X=0$ or $X=6$, that is, where either nobody has an EFTS account, or everybody has. Then, at least differentiation of prices and endowments would be required to sustain a pseudo-equilibrium with an interior solution in X.

Considering the production and supply side of the economy, even if I was to assume that the individual firms respond as profit maximizers to parametric prices, there would still be some difficulty to handle the pricing related to the discrete terms referring to access.

If I was to have individual pricing and lump sum payments varying in size (and sign) between individuals, such that the income distribution ex post would be perfectly compatible with any societal welfare function, the necessary conditions that I should obtain from the profit and utility maximization for the micro-units would still not imply an allocation of resources satisfying the results obtained in the previous section of this paper. It would take a more complicated pricing scheme than that contained in perfect competition to sustain the efficient conditions. As I saw in a previous section, these conditions would have three components, difficult to handle from a pricing point of view. These three components are:

1) a "public good" component (access to the system),

2) a "transaction cost" component (involving savings in participation costs), and

3) a "discreetness" component.

I have attempted here to analyze some properties of the EFTS, as they relate to the pure theory of public goods. In the process, I have used some highly simplifying assumptions. Although these have enabled me to cast the problems in a general equilibrium framework, the results have come at a price. The analysis has been static. I have been forced to assume that the individual consumer obtains or receives either the bundle $[Y^0, 0, t^0]$ or the bundle $[Y^1, X, t^0]$.

Now I shall attempt to remedy these deficiencies. I shall introduce in a meaningful way incomes and the distribution of incomes, because acceptability of the EFTS is not the same among poor and rich, or even among firms and households, because of the differences in their incomes, their needs and their preferences. This way I shall redirect my attention away from the production side and towards the demand side.

**THE DEMAND FOR EFTS SERVICES**

Now I shall try to construct a growth model of the demand for EFTS services. I suppose that over a time interval (dt), a number of new participants, say (Xdt), opened EFTS accounts. Then, in terms of my previous analysis, the associated argument that enters their preference function is [X + Xdt]. In other words, potential use of the EFTS (access, in my terminology) is cumulative, like a stock, and is not in the nature of a flow. Thus I can regard my access variable (X) as related to time in the following way:

$$X\ (t) = I^{t}_{0}\ X\ (S)\ dS \qquad (17)$$

As before, let 6 denote the size of the total population in the national market, and $P_X$ denote the participation fees for EFTS services. Let Z denote the level of an individual's income and Θ(Z) be a continuous, strictly increasing cumulative distribution of income, expressing the share of the total population with income below Z.

My first assumption, then, is that the total population 6, the distribution of income Θ(Z), and the price of EFTS participation $P_X$ are all independent of time, and thus stationary.

I realize that by assuming a growing population, growing incomes, and possibly a changing income distribution and changing relative prices, my analysis would become more "realistic". But that is not my purpose. Instead, I wish to show that even if there is no population and income growth, etc., I can still obtain a sustained growth process.

My second assumption is that the distribution of EFTS accounts among individuals is such that the order of new participants entering the EFTS is the order of their income:

$$X\ (t) = 6\ [\ 1 - \Theta\ f(t)\ ] \qquad (18)$$

where X(t) is the total number of EFTS accounts in period t, and f(t) is the income level beyond which all individuals have access to the EFTS in period t.

My third assumption is that the preferences of individuals can be represented by a utility function:

$$U(y, *x) \tag{19}$$

continuous and strictly increasing in y and in $*x$, and where y is the consumption of private goods by the individual, x is the number of EFTS accounts to which the individual has access, and

$* = 1$ if the individual has an EFTS account

$* = 0$ if the individual has no EFTS account

My fourth assumption is that at any time each individual maximizes his utility subject to his budget constraint:

$$\text{Max } U [\, y(t+1), *x(t) \,] \tag{20}$$

with respect to y(t+1), and $*$, subject to:

$$y(t+1) + * P_X = Z(t+1) \tag{21}$$

Here, and without any loss of generality, I assume the price of the private goods equal to unity: $P_y = 1$. Finally, I assume that x(0) and x(1) are given, such that x(1) > x(0). In other words, I assume that some factor exogenous to the model has initiated a change in the number of EFTS accounts. Given the above assumptions, the sequence of x(t) increases. To prove this proposition, I reason by recurrence. Assume: x(t) > x(t-1), then

$$U [\, f(t) - P_x, x(t) \,] > U [f(t) - P_x, x(t-1) \,] \tag{22}$$

This follows from the assumption that U is strictly increasing in x. By continuity of U, there exists Z < f(t), such that:

$$U [Z - P_x, x(t)] > U[f(t) - P_x, x(t-1)] = U [f(t), 0] \tag{23}$$

Here, the last equality is obtained by the definition of f(t).

Since $Z < f(t)$, it follows from the assumption that U is strictly increasing in y that:

$$U [ Z, 0 ] < U [ f(t), 0 ] \tag{24}$$

Thus, there exists $Z < f(t)$, such that:

$$U [ Z - P_x, x(t) ] > U [ Z, 0 ] \tag{25}$$

This means that in period (t+1) new demand is generated for EFTS services from individuals with incomes somewhat below f(t). Accordingly:

$$f(t+1) < f(t) \tag{26}$$

and since $\Theta(Z)$ is strictly increasing, it follows:

$$x(t+1) > x(t) \tag{27}$$

This result is also in accordance with the argument that regarding the acceptance of the EFTS, and therefore, the future demand for EFTS accounts, we must not judge how we fill, but how the new generation, the bank customers of tomorrow will feel about the electronic payments system. The younger generation who are becoming the new bank customers is expected to be less afraid of machines, computers and automatic banking.

To summarize, it has been assumed that: $x(1) > x(0)$, and it has been proved that: if $x(t) > x(t-1)$, then $x(t+1) > x(t)$.

Thus, the sequence in x is increasing. Being bounded above by 6, the sequence converges. It converges either to 6 or to some $x^*$, $x^*<6$, which, if it exists, must satisfy:

$$U \{\Theta^{-1} [(1-x^*)/6] - P_x, x^*\} = U \{\Theta^{-1} [(1-x^*)/6], 0\} \tag{28}$$

Obviously, the shape of the function U and $\Theta$ will influence the value to which the sequence converges.

To conclude, I consider an illustration of the theoretical results, through the use of specific functions U and $\Theta(z)$. I try to find a utility function and an income distribution function which would, on the one hand, satisfy the standard economic theory assumptions imposed on such functions and, on the other hand, generate a logistic curve, (to model the growth of $\Theta(z)$ when inserted in my analytical framework.

I consider the following cumulative distribution of income function:

$$\Theta(z) = e^{-\exists/z} \tag{29}$$

and the following utility function:

$$U [ y, *x ] = U_1 (y) + U_2 (*x) \tag{30}$$

where: $\exists > 0$

$$U'_1\,(y) = 6/P_x\,[1 - e^{-\exists/(}]$$

$$U_2\,(*x) = *\,[\,(1+\forall 6)\,x - \forall x^2\,]$$

$$\forall > 0$$

$$\forall < (1/6)$$

Here, both $U_1$ and $U_2$ are strictly increasing and concave. The behavior of x(t) is thus the consequence of the assumptions above and of the specific shape of the functions U and $\Theta$ that an accumulation of EFTS accounts will occur, governed by the differential equation:

$$\dot{x}/x = \forall\,(6 - x) \tag{31}$$

The solution of this differential equation yields a logistic curve.

My result shows that a growth process in the demand for EFTS accounts can be explained jointly by the distribution of incomes and the cumulative public good property inherent in the EFTS, which I have described and analyzed. Recalling my assumptions of a constant population, constant incomes, a stationary income distribution and no change in relative prices, I venture the observation that the result is interesting. The use of a specific utility function and a specific income distribution are illustrative. From them I derive the logistic curve which I expect to describe the demand for the EFTS accounts.

## CONCLUDING REMARKS

It goes without saying that only a few of the many interesting analytical aspects of the EFTS have been analyzed in this paper.

The pricing and equity problems deserve much closer scrutiny than I have afforded them. Peak-load and waiting-line type of problems deserve attention, also, in the public-good context.

The point should already be clear from the paper that the welfare gains to society arising from the EFTS (in almost whatever measure we care to express them), are vastly greater than the costs. This conclusion justifies the assertion that EFTS is an efficient payments mechanism and, sooner or later, will become an inseparable part of our life. If this would be so, then economists should direct properly their present theoretical research for a better understanding of the consequences from this evolution.

A more complicated, but related issue, not dealt with in this paper, concerns the rate of growth in benefits and costs over time, and this topic deserves further analysis.

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