The objective of this paper is to discuss the overall role of digital money and its impact on welfare and monetary policy. The role of digital money is discussed under a review of literature and through a simple theoretical model that captures technological advances. In this model the representative consumer decide over two key elements: consumption and leisure. Here, the leisure are affected by transaction costs and the amount of money available. To simulate the model’s result, I use data for Brazil. As general result, I predict that digital means of payment will improve welfare and increase the overall demand for money.
1. Introduction

In my view digital money, sometimes mentioned in the literature as e-money or e-cash, is any form of electronic payment mechanism. This definition is very much compatible with the ones proposed by Dias, Dias & Silva (2000) and Wan (1999).

As a mechanism of payment it is supposed to impact the economy on two grounds. First, on the monetary policy aspect where its widespread use by consumers lead to paper money substitution on the day by day transaction. Second, on the welfare of the consumers. If society’s welfare improves it will stay longer; otherwise it will not be used. Seeking to see the impact of digital on both variables, I start the paper with a brief review of literature on digital money.

2. Review of Literature

This review of literature is drawn extensively on Dias, Dias & Silva (2000). Therefore, for a more detailed discussion I recommend to look that paper.

Digital payment system coupled with safe cryptographic resources according to the American Banks Association (1996) has the lowest transaction cost. It has an estimated cost of US$ 0.01. When compare that with traditional one make at the banks which is US$ 1.075. This overwhelming cost reduction will make without doubt digital money a serious candidate to substitute paper money.

North (1994), showed that the changes in money’s form along the history were done exclusively based on transaction cost reduction to final users. So, history is keeping its pattern on today modern society.

The digital money literature can be divided into two groups. The first composed by those that argue in favor of maintaining digital money as inside money, keeping its parity on paper money [Konvisser (1994), Bernkopf (1996) and Greenspan (1996)]. Here, the monopoly of issuing paper money or digital money should in the hands of the central bank. The second, composed by those that defend more competition [Chaum (1995), Montanis (1995), Ely (1996), England (1996) and White (1996)]. According to them, digital money is an outside money -- notes issued by private banks. Here the supervision cost of the private is transferred to consumers.

The centerpiece of the discussion between the two groups is about the seigniorage. The seigniorage is between 1.5% - 3% of government revenue for developed countries, according to Cukierman, Edwards and Tabellini (1992).

The introduction of digital money will certainly move some of the revenue if not all to issuing companies of digital means of payment, even
though the money is inside. In our view, the monetary policy will still be valid.

In our view, the digital money as an outside money will not become a reality. As an outside money it increases consumers transaction costs, since it demands constant supervision by consumers. Therefore, it goes against the history of money and the theory to be developed next section.

3. The Model

It is important to have in mind the focus of the model. Here, the very important aspect is the welfare of the society. The changes proportioned by technological advances must reflect in the welfare improvement of the society. Otherwise, it will not become a permanent technological mechanism to be used by society.

On the economical aspects, the technology advances are in last instance simple transaction cost reduction and time saver. The effect of technological advances on the society’s welfare can be seen in the following graph.

Figure 2: The Transaction Costs Effect

The welfare function ($W$) is composed of two variables: total consumption ($TC$) and leisure ($L$). A technological shock ($S \rightarrow S'$) that reduces transaction costs and is time saver would increase the total leisure from $L$ to $L'$ and the total consumption from $TC$ to $TC'$. Bringing a welfare improvement from $W$ to $W'$. This welfare improvement will be brought by a lower transaction cost.

Santomero-Seater (1994) and Berentsen (1998) studied the demand for digital money. Dias, Silva & Dias (1999) besides deriving a more complete demand function, they also analyzed the impact on the demand for money due
to the adoption of digital money. Here, I advance in relation to Dias, Dias & Silva (2000) by building a theoretical model that enable me to verify the welfare impact caused by technological advances that lowers transaction costs. The verification will be done through simulation using Brazilian data. These are the two objectives of the model to be developed henceforth.

The representative consumer has the following welfare function (W):

$$ W(c_t, \ell_t) = E_0 \sum_{t=0}^{\infty} \beta^t \{e^{-t\alpha} + \ell^\alpha_t \}, $$

where: W is the consumer’s welfare function and c_t is the consumption and \( \ell_t \) is the leisure, both at time t; \( E_0 \) is the expected operator; \( \beta \) is the discount rate. The leisure function is represented by the following equation:

$$ U(s_t, m_t) = \ell_t = s^{-s} m^s, $$

where: \( s \) is the transaction cost \( 0 < s < 1 \). The variable \( s \) captures technological advances like the digital money. A lower \( s \) means that more transactions can be made with the same amount of money, \( m \). Therefore, leisure will increase because more money will be available at the cost already incurred by the consumer.

The consumer’s budget constraint is given by the following function:

$$ P_t y + M_{t-1} + (1-R_{t-1})B_{t-1} = P_t c_t + M_t + B_t. $$

Where \( P_t \) is the price index; \( M_t \) is the nominal money at time t; \( R_t \) is the nominal interest rate; \( B_t \) is the amount bonds (or debits) at time t; \( c_t \) is the consumption in period t.

The model’s solution consist of equating through time the utility from extra time leisure from a incremental unit of money with the utility of extra money times the interest forgone by this same unit of money.\(^1\) The mathematical solution of the system consists of maximizing equations (1) and (2) subject the constraint of the equation (3). This is equivalent to solve the following equation:

$$ \frac{\partial W}{\partial \ell_t} \frac{\partial U}{\partial m_t} = \left\{ \frac{R_t}{1+R_t} \right\} \left\{ \frac{\partial W}{\partial c_t} + \frac{\partial W}{\partial \ell_t} \frac{\partial U}{\partial s_t} \right\} $$

\(^1\) For those interested in the details of the solution see for example McCallum (1989).
Where \( \partial \)'s represents the derivatives of the functions with respect to the variables and \( R_t \) is the interest rate. The solution can be easily found by taking the derivatives of equations (1) and (2).

\[
\frac{\partial W}{\partial c} = W_1 = (1 - \alpha)C^{-\alpha} (s^{-a} m^{a})^\alpha \\
\frac{\partial W}{\partial \ell} = W_2 = \alpha \ell^{-\alpha} (s^{-a} m^{a})^\alpha \\
\frac{\partial U}{\partial s} = U_1 = -\alpha s^{-a-1} m^a \\
\frac{\partial U}{\partial m} = U_2 = \alpha s^{-a} m^{a-1}
\]

Now, I substitute equations (5)–(8) into equation (4). After simplifications, I get the following:

\[
m_t = \left( \frac{\alpha ac}{1 - \alpha - \alpha a \frac{c}{s}} \right) \left( 1 + \frac{R}{R_t} \right)^{-1}
\]

The above equation shows that a reduction in transaction cost caused by a technological advance, like the digital money, equivalent to a lower \( s_t \) in equation (9), will increase the overall demand for money. However, paper money is the one being substituted here. Thus, digital money will reduce the government revenue made from seigniorage.

Over the long run policy makers in order to keep a compatible monetary policy must be attempt to this demand increase. The general form for the equation (7) would be the following:

\[
\frac{M_t}{P_t} = L \left( c^+, R, s_t \right)
\]

The demand for money will increase with consumption, technological advances -- smaller \( s_t \), and with interest rate decrease.

4. Simulation for the Brazilian Economy
In this section I will use the Brazilian data to analyze the impact of technological advances on welfare and monetary policy. The baseline line data for December of 1999 was obtained from Conjuntura Econômica (2000). The idea is to simulate the impact of 1% reduction in transaction cost due to the use of digital money through equation (9).

The baseline data for Brazil are the following:

\[
\begin{align*}
\text{GDP} &= \text{US$ 775.50 billions;} \\
\text{M1} &= \text{US$ 50.88 billions;} \\
\alpha &= 0.02;^2 \\
\text{s} &= 1;
\end{align*}
\]

First, I use equation (9) to obtain the value for \( a \) at the baseline year. The result gave is \( a = 0.069142 \). This is the elasticity of leisure with respect to technological advances. The total welfare is \( W=563.7451 \), equation (1).

Now, I use these numbers to simulate a technological advance that lead to a 1% transaction cost reduction or equivalent to make \( s = 0.99 \). The impact on the overall money demand is of 8.21%, therefore reaching US$ 55.41 billions and the rate of total welfare improvement is 0.0104% or \( W=563.804 \). Although this impact on the total welfare seems so dismal it is not in economic terms, since this is an overall welfare improvement. I simulate a welfare improvement on the same size through the use of the interest rate as a policy instrument. To obtain the same welfare improvement, the interest rate in Brazil must be reduced in 1.6%.

The digital money impact on monetary policy is done through an overall demand increase for money and by suppressing the need of paper money. As it can be seen from above, a 1% transaction cost reduction increase the demand for money by as much as 8.21%. This huge impact captures the new aspect of the digital money that is making more of it for transaction at lower cost. However, more studies need to be done in this field in order to drawn a precise conclusion on the magnitude of the impact on the money demand.

5. Conclusion

From the review of literature I learn that there is not much chance for outside money to happen. The transaction cost that comes with outside money is a high price to be paid by consumers. Therefore, it goes against the money development history. In sum, money will be inside which means controlled by government.

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2 From Dias (2000).
The welfare and monetary impact to be caused by the use of digital money will be in three fronts. First, it will reduce the need for paper money and consequently reduces government revenue from seigniorage; second, it will increase the overall demand for money, third, it will improve the overall welfare of society.

As mentioned before any means of payment mechanism must bring with it welfare improvement in order to be accepted by society. The digital money seems to fulfill very well this condition.
6. BIBLIOGRAPHICAL REFERENCES

http://www.aba.com
BERNKOPF, M. Electronic Cash and Monetary Policy. First Monday. 
www.firstmonday.dk/issues/issue1/ecash/index.html
Obsolete. Publications from Digicash. Virginia,
Vargas, V.54, N.6.
and Their Impact on the Economy. In: Business Briefing: Global Electronic 
Commerce – Forum on Electronic Commerce for Transition Economies in the 
Digital Age – Organized by the Committee for Trade, Industry and Enterprise 
Impact on the Economy. BEJE - Brazilian Electronic Journal of Economics. V.2, 
DIAS, M.H. (2000). A Revision on the Welfare Costs of Inflation and Seignorage in Brazil: 
A Model with Leisure. UEM-PME working paper.
Cato Institute’s 14 Th Annual Monetary Conference. Washington, D.C.
Annual Monetary Conference. Washington, D.C.
WoPEc Working Paper 9607004. 
http://netec.wustl.edu/WoPec/data/Papers/wpawuwpma9607004.html
KONVISSE, J. B. (1994). Coins, Notes and Bits: A Case for Legal Tender on the 
Internet. University of Texas at Austin Press, Texas,
www.cox.smu.edu/class/mis4350b/people/things/concert/concept.html
Londres,
Washington, DC.

http://www.geocities.com/CollegePark/6873/Mondex.htm


http://www.geocities.com/CollegePark/6873/Mondex.htm