On the Complementarity of Money and Credit

Leo Ferraris*
LSE

May 2005

Abstract

I construct an economy with microfoundations for the use of money and bilateral credit as media of exchange. The model features spatial separation, absence of double coincidence of wants and competitive markets. Money is the means of payment: in equilibrium, bilateral credit is cleared with money. The model generates predictions for the effect of inflation on macroeconomic variables. The real interest rate increases with inflation. Credit, output and welfare all decrease with inflation.

Keywords: Coexistence of Money and Credit; Interest rate; Inflation.

JEL Classification: E40, E43, E50

*I would like to thank John Hardman Moore for his guidance throughout this project. I benefited from comments by Nobu Kiyotaki, Leonardo Felli and Luigi Guiso. I would also like to thank seminar participants at LSE, University of Madrid Carlos III, Federal Reserve Bank of New York, Bank of England, Ente Einaudi, Vanderbilt University. Remaining errors are mine. Correspondence: Leo Ferraris, London School of Economics, Economics Department, Houghton Street, WC2A 2AE, London, UK, e-mail: l.ferraris@lse.ac.uk

1 Introduction

Money performs four main functions. It is a unit of account, a store of value, a medium of exchange and a means of payment. The most neglected in the literature has been the means of payment function -i.e. the means to settle debt-. Other objects can play the role of unit of account, store of value or medium of exchange. Only money however acts as the means of payment[1]. The aim of the present paper is to construct a model where money serves as the means of payment. To address this issue, an environment is needed where agents use both money and credit as media of exchange. I consider a specific form of bilateral credit, promissory notes, and show that money is used to settle bilateral promises.

The model features lack of double coincidence of wants and spatial separation. When purchasing goods, agents can use fiat money to overcome the absence of double coincidence of wants and they can buy on credit issuing bilateral promises. The lack of double coincidence of wants has been crucial to explain why money is useful in lubricating exchange, ever since the works of Menger and Wicksell. Kiyotaki and Wright (1989) constructed a search model around the lack of double coincidence of wants to explain the use of money as a medium of exchange. In order to make money essential however they had to introduce limitations on enforcement and commitment, thus ruling out alternative means of exchange as multilateral and bilateral credit. Specifically, they assumed that no public memory technology was in place and agents couldn't commit to future actions. Kocherlakota and Wallace (1998) studied multilateral credit as an alternative medium of exchange, introducing in the Kiyotaki and Wright model a public memory technology. In their model multilateral credit -which resembles a credit card system- is a claim to future commodities, not to money. In their model money and credit are substitute. I rule out any public memory technology and thus multilateral credit. I assume that agents can use collateral to commit to keep their bilateral promises. Repayment is decentralized and requires time. Markets are walrasian and money is durable

[1] "A medium of exchange includes those assets, or claims, whose transfer to the seller will commonly allow a sale to proceed. Payment is in some sense final. The most important general function of money is to serve as a means of payment."(Goodhart (1989))

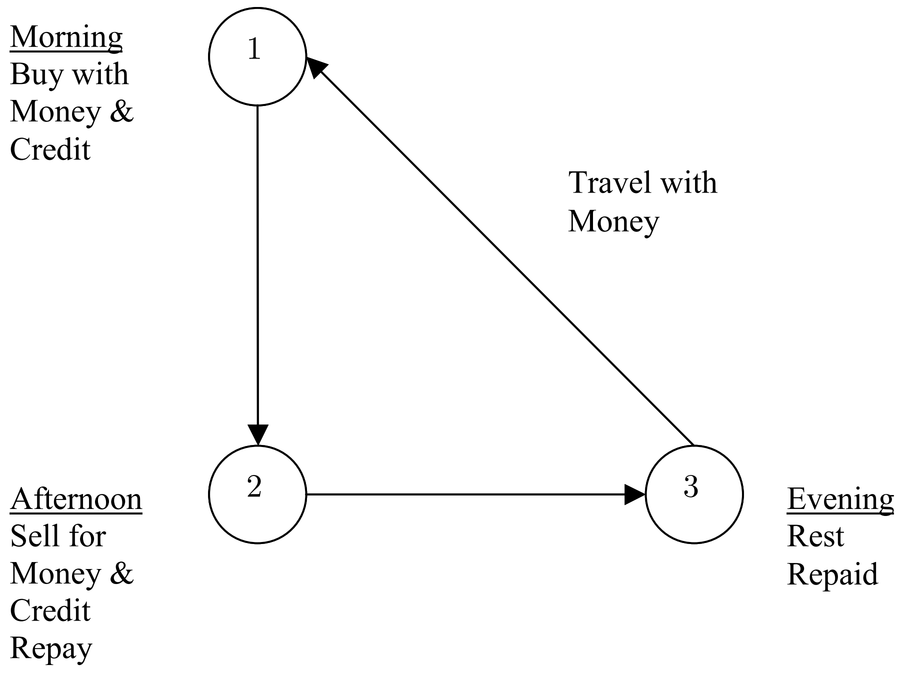

Figure 1: Life of an Agent

and perfectly divisible. I drop the assumption, typical of the search theory of money, that agents meet at random and assume that agents can choose their itineraries: this allows me to avoid restrictions on money holdings and study an economy with general portfolios of money. I assume that a day is divided in three periods of eight hours. Each period can be used to either consume, produce or rest. After producing, agents need to rest for eight hours during which they will not be able to either consume or produce. This assumption captures in a simple, deterministic way a time mismatch between the arrival of liquidity and of consumption or production opportunities, inducing agents to hold money for some time before being able to spend it.

In equilibrium each agent uses both money and bilateral credit to exchange commodities and bilateral credit is repaid with money. The typical life of an agent in the economy is summarized in Figure 1. In the morning, agent 1 is on his island, where he purchases commodities with money and promises. Then he travels to island 2 together with his creditor. In the afternoon he produces for money, repays his debt and produces for promises becoming a creditor himself. Then he travels with his debtor to island 3 and in the evening -his period of rest- he waits for his debtor to repay. Finally he travels to island 1 with money and the next morning the cycle restarts. Output and welfare are higher than in the corresponding economy without bilateral credit, credit bears interest and money serves to repay debts: money and credit are complementary.

The model generates the following predictions on the effect of anticipated inflation on macroeconomic variables. Anticipated inflation drives up the nominal interest rate. The elasticity of the nominal interest rate to inflation is greater than one and thus the real interest rate increases with inflation. Unit elasticity of the nominal interest rate is known as the Fisher effect. In the model, the failure of the Fisher effect is due to the time mismatch between the arrival of liquidity and consumption opportunities. Creditors need to be compensated for holding money for one period in an environment with inflation. The credit to money ratio decreases with inflation, since inflation increases the opportunity cost of holding a promise of future money more than the opportunity cost of holding money itself. Green (2002) argues that inflation may destroy the acceptability of money in a model where debt is not settled with money, but not in a model where money serves as the means of payment. Here I argue that inflation may harm credit. Output and welfare decrease with inflation. Inflation, harming credit, reduces the amount of transactions performed and thus reduces output. In Tobin (1965) anticipated inflation induces agents to substitute in their portfolios capital for money thus increasing the capital stock and output and decreasing the real interest rate. In the literature this is known as the Mundell-Tobin effect. The model, therefore, generates a reverse Mundell-Tobin effect: credit and output decrease with inflation, the real interest rate increases with inflation. Section 2 describes the model. Section 3 derives the equilibrium and the predictions. Section 4 concludes.

2 The Model

Time is discrete and continues for ever. Agents are infinitely lived. They can consume, produce and rest. There are $N > 4$[2] islands arranged on a circle, indexed by $j = 1, ..., N$.

[2] $N > 4$ guarantees that promises cannot be simply swapped instead of being repayed.

Day

	Evening	Morning	Afternoon	Evening	Morning
Type 1	Rest	**Consume**	**Produce**	**Rest**	Consume
Type 2	Consume	**Produce**	**Rest**	**Consume**	Produce
Type 3	Produce	**Rest**	**Consume**	**Produce**	Rest

Figure 2: A Day: Height Hours Shifts

Each island is inhabited by a continuum of mass three of agents. On each island j one and only one type of perishable commodity (j) can be produced: agents j consume commodity j and produce commodity $j+1$ (modulo N) only. After producing individuals need to rest for one period: they will not be able to consume or produce for one period[3]. In order to clear the markets, some of agents j will be consuming in the morning, producing in the afternoon and resting in the evening (type 1), some others producing in the afternoon, resting in the evening and consuming in the morning (type 2) and finally some resting in the evening, consuming in the morning and producing in the afternoon (type 3). There will therefore be eight hours periods in a day and agents will do either the morning, afternoon or evening shift. (See Figure 2).

Every ordered pair of islands is connected by ships. Agents are free to choose their itineraries. On each island competitive markets for the exchange of the local commodity open each period, closing at the end of the period. When agents arrive on the island they are randomly matched to a trading partner. They can however be randomly re-matched without cost to another trading partner if they want to. This assumption -together with the fact that there is a continuum of agents- keeps the price competitive. At the beginning of time, on each island, there is an amount M of fiat money, in the form

[3] For simplicity I assume that the disutility of consuming or producing without resting is infinite. A finite disutility would be enough.

of durable and worthless pieces of paper. Agents have also the option of issuing their own promises. There is no central record-keeping technology to monitor and enforce promises. Each agent has an amount of durable collateral specific to him without which he is unable to consume[4]. When issuing a promise, each agent surrenders his collateral to his trading partner in exchange for the commodity he purchases. Repayment takes time: the issuer of a promise needs to go back to his island, produce and sell in order to gain the money needed to make final payment. There is no clearing-house for promises[5]. Enforcement is limited. At all times agents can simply decide not to participate in the exchange process. On each island there are competitive markets for the exchange of goods for money (the money market) and for the exchange of goods for promises (the credit market).

Agents are characterized by a utility function which is linear in consumption $u(x_{t,j}) = x_{t,j}$ where $x_{t,j}$ is the quantity bought at time t on island j and a cost function -in terms of utils- which is quadratic $c(y_{t,j}) = \frac{1}{2}(y_{t,j})^2$ where $y_{t,j}$ is the quantity produced by producer j.[6] The objective of an agent of type j is to maximize

$$\sum_{t\in T}\beta^t\left[x_{t,j}^M + x_{t,j}^C - \beta\frac{1}{2}\left(y_{t+1,j+1}^M + y_{t+1,j+1}^C\right)^2\right]$$

where $T = \{1, 4, 7, ...\}$ in order to take into account the resting period and $0 < \beta < 1$ is the time discount rate. $x_{t,j}^M$ and $x_{t,j}^C$ are the quantities of good j bought at time t by agent j on the money market and on the credit market respectively, while $y_{t+1,j+1}^M$ and $y_{t+1,j+1}^C$ the quantities of good $j+1$ sold for money and for credit. Define the price on the money market for good j at time t as $p_{t,j}$ and the price on the credit market as $q_{t,j}$.

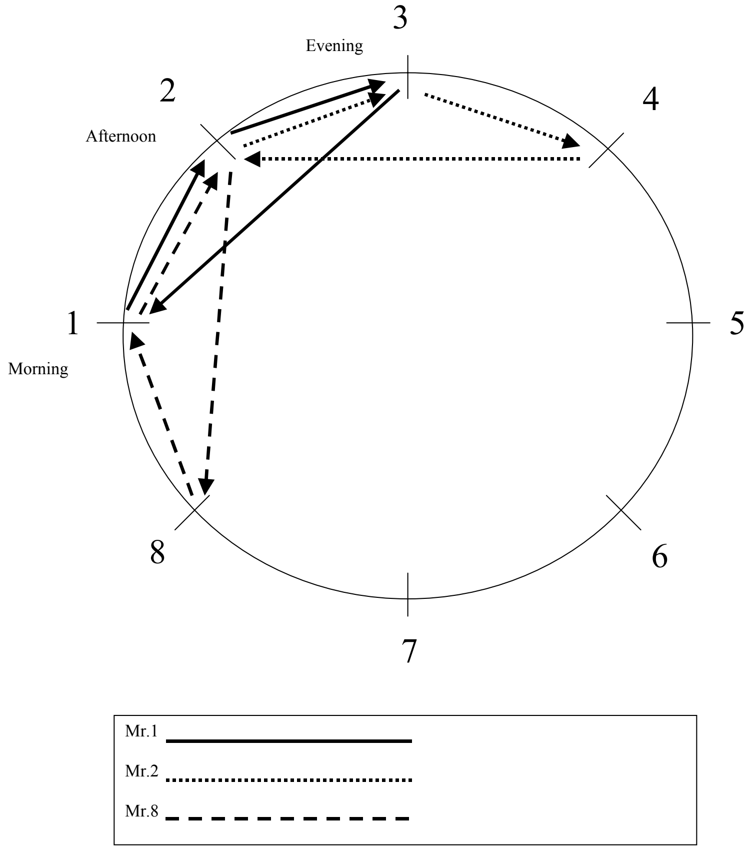

Figure 3: Sequence of Events

2.1 Sequence of Events

Let me first describe the sequence of events informally. For simplicity, suppose there are 8 islands. Figure 3 summarizes the sequence of events. In the morning, agent 1 is on island 1. He spends money to buy his consumption good from agent 8. He then increases his purchases issuing bilateral promises secured by collateral. At the end of the

[4]For simplicity, again, I assume that the disutility of consuming without the collateral is infinite. A finite disutility would be enough.

[5]Freeman (1996) has a model with overlapping generations of agents where purchases are made with debt, debt is settled with a final payment of fiat money and there is a market for the resale of debt. Unlike the present paper, the clearing system is centralized.

[6]Quasi-linearity is crucial. The specific functional forms are not.

morning agent 1 and 8 travel together to island 2[7]. Meanwhile agent 2 is also coming to island 2. In the afternoon, agent 1 sells goods to agent 2 for money. With the money he received, he repays agent 8 and gets his collateral back. He then sells goods to agent 2 for promises, becoming a creditor. At the end of the afternoon he travels with agent 2 to island 3. Meanwhile agent 8 travels to his consumption island. In the evening, agent 1 will be resting and waiting for repayment. The next morning he will restart the cycle.

Formally the sequence of events is as follows. Agent j at time t uses part or possibly all of the money he accumulated in the past (m^j_{t-1}) to buy goods on the money market $p_{t,j}x^M_{t,j} \leq m^j_{t-1}$; he then proceeds to buy on the credit market borrowing an amount $d^j_t = q_{t,j}x^C_{t,j}$; at $t+1$ he produces for money in order to pay off his debt $p_{t+1,j+1}y^M_{t+1,j+1} = m^j_{t+1} \geq d^j_t$; he then lends an amount $b^j_{t+1} = q_{t+1,j+1}y^C_{t+1,j+1}$; at $t+2$, he follows his debtor on island $j+2$ and obtains, as a repayment, an amount of money $m^j_{t+2} = b^j_{t+1}$. At time $t+2$ he also receives a lump-sum money transfer $\tau_{t+2,j}$ from the government. The previous sequence of exchanges gives rise to the following three constraints: a standard cash-in-advance constraint

$$p_{t,j}x^M_{t,j} \leq m^j_{t-1}$$

a repayment constraint

$$p_{t+1,j+1}y^M_{t+1,j+1} \geq q_{t,j}x^C_{t,j}$$

which states that the amount of money obtained producing has to be at least enough to repay the debt, embedding the relationship of complementarity between money and credit in an otherwise fairly standard cash-in-advance framework; the budget constraint

$$m^j_{t+2} = q_{t+1,j+1}y^C_{t+1,j+1} + p_{t+1,j+1}y^M_{t+1,j+1} - q_{t,j}x^C_{t,j} + m^j_{t-1} - p_{t,j}x^M_{t,j} + \tau_{t+2,j}$$

which says that the amount of money an agent carries into the following three period cycle is equal to the amount he obtains as a repayment of credit, the amount left after repaying and after consuming and the lump-sum transfer from the government.

[7] Agents are randomly matched once they arrive on an island. Since there is a continuum of agents, a debtor and a creditor may not find each other again. To overcome this problem I make them travel together.

The economy features limited enforcement. Agents can always secure themselves at least zero, not participating in the exchange process. The relevant participation constraint states that producing tomorrow for promises and consuming in three periods must give non-negative utility:

$$\beta^{t+3}\left(x_{t+3,j}^{M}+x_{t+3,j}^{C}\right)-\beta^{t+1}\frac{1}{2}\left(y_{t+1,j+1}^{M}+y_{t+1,j+1}^{C}\right)^{2}\geq 0$$

On each island, the government issues money every period and gives lump-sum transfers to agents in their period of rest[8]. The government budget constraint equates, for each island j, the increase in the money supply to the total transfers to agents $M_t^j - M_{t-1}^j = T_t^j$. The money supply grows at a rate z_t^j :

$$M_t^j = \left(1+z_t^j\right) M_{t-1}^j$$

2.2 Main Assumptions

The model features five main assumptions:

1. absence of double coincidence of wants and spatial separation are necessary to give money a role as a medium of exchange;
2. absence of a record keeping technology rules out multilateral credit contracts;
3. enforcement is limited;
4. collateral makes the exchange of promises possible, giving agents a limited form of bilateral commitment power;
5. agents do not always participate in the exchange process: they have to rest after producing. Rest is crucial to generate an essential role for credit as a medium of exchange.

The main differences with a search model are that markets are competitive and agents can choose their itineraries. This allows me to lift the $\{0,1\}$ restriction on money

[8] I assume that agents receive transfers only when they are resting in order to rule out redistributive effects of monetary policy.

holdings, typical of the search theory of money, and analyse a model where general portfolios of perfectly divisible money can be held. Absence of double coincidence of wants alone wouldn't be enough to induce a role for money as a medium of exchange if agents could meet in the same market place and strike multilateral deals. Spatial separation of markets prevents multilateral deals.

The paper focuses on the interaction of money and bilateral credit rather than multilateral credit. I therefore rule out all devices allowing agents to exchange multilateral credit contracts. In fact I assume that there isn't any technology allowing agents to keep track of each other. I also rule out enforcement technologies and any technology allowing agents to commit to future actions other than collateral. Kocherlakota (1998) shows that in a world with full enforcement and commitment money would not be needed as a medium of exchange.

Collateral in the model is individual specific, has no public value and is necessary to consume. The reader can think of a consumption tool as in Shi (1996) or alternatively of a blueprint for future production. In the model the borrower leaves the collateral with the lender until the debt is repaid. Such a form of collateralized borrowing is known as a repurchase agreement (repo). The fact that collateral is necessary to consume rules out default.

Agents need to rest for one period after producing. This assumption captures in a simple way a mismatch in the arrival of liquidity and of consumption, investment or production opportunities. Agents hold money for some time before being able to spend it.

3 Equilibrium

In a stationary symmetric competitive equilibrium, agents maximize utility subject to the cash-in-advance constraint, the repayment constraint, the budget constraint and the participation constraint; all markets clear at all times: the goods-for-money market $x_t^M = y_t^M$, the goods-for-credit market $x_t^C = y_t^C$, the market for money $m_t = M_t$; the Government fulfills its budget constraint and sets $z_t = z \geq 0$ at all times. By

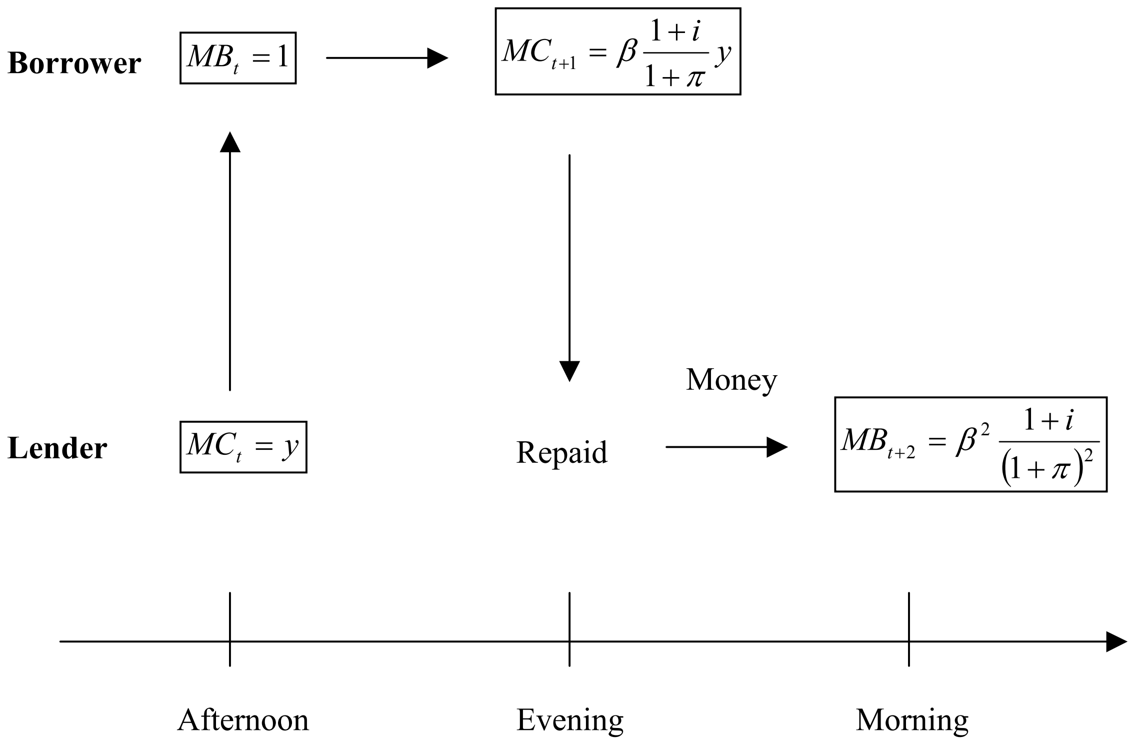

Figure 4: Euler Equations

money market clearing, the inflation rate π is equal to the growth rate of money z: $\pi = \frac{p_{t+1}-p_t}{p_t} = \frac{M_{t+1}-M_t}{M_t} = z$. Define the interest factor $(1+i_t) = \frac{q_t}{p_t}$ as the ratio of the price of goods for promises (tomorrow's dollars) to the price of goods for money (today's dollars). Define total output as $y = y^M + y^C$. If sufficiently patient, agents are willing to participate in the exchange process. The participation constraint is slack when $\beta > \left(\frac{1}{4}\frac{1}{1+\pi}\right)^{\frac{1}{3}}$. Figure 4 (where MB stands for marginal benefit, MC for marginal cost) depicts the behavior of a borrower and a lender.

The Euler equations are

$$1 = \beta \frac{1+i}{1+\pi} y \tag{1}$$

which describes the behavior of a debtor who increases his utility in the afternoon borrowing an extra unit (LHS) and will have to repay his debt with interest producing an extra unit in the evening (RHS); and

$$y = \beta^2 \frac{1+i}{(1+\pi)^2} \tag{2}$$

which describes the behavior of a creditor who is lending an extra unit in the afternoon (LHS) and will get repayment with interest in the evening but will be able to spend it only the next morning since he has to rest during the night (RHS). There is a time wedge between the borrower -who cares about one period ahead- and the lender -who cares about two periods ahead, because of the resting period-. The creditor is holding money overnight, before being able to spend it. The repayment in real terms equals the amount borrowed plus interest discounted by the inflation factor:

$$y^M = \left(\frac{1+i}{1+\pi}\right) x^C \tag{3}$$

which gives, using the equilibrium condition on the credit market -$x^C = y^C$-, the ratio of the amount produced in the economy for credit and the amount produced for money -the credit to money ratio-.

The equilibrium nominal interest rate, output and credit to money ratio are derived solving (1),(2) and (3). The nominal interest factor is more than unit elastic in the inflation factor, with elasticity equal to 1.5:

$$1+i = \left(\frac{1+\pi}{\beta}\right)^{\frac{3}{2}}$$

In equilibrium there is a positive interest rate. This is necessary for a promise of money-later to be accepted instead of money-now. Total output, which is given by

$$y = \left(\frac{\beta}{1+\pi}\right)^{\frac{1}{2}}$$

is higher than output in the corresponding economy with only money -$\widehat{y} = \left(\frac{\beta}{1+\pi}\right)^2$-, but lower than output in the first best - $y^{FB} = 1$-. Credit is an interest bearing medium of exchange. The higher return induces agents to produce more compared to an economy without credit. The ratio of credit to money is given by the repayment constraint, embedding complementarity:

$$\frac{y^C}{y^M} = \frac{\beta^{\frac{3}{2}}}{(1+\pi)^{\frac{1}{2}}}$$

which is decreasing in inflation. With inflation, the opportunity cost of holding a claim to future money is higher than the opportunity cost of holding money itself. In a model where money and credit are seen as substitute the reverse would be true. Gillman (1993) modifies a cash in advance economy à la Lucas and Stokey allowing the representative agent to decide which goods to buy with cash and which goods with a costly transaction technology producing credit services, with no role for cash as a means of settlement, and shows that "the consumer chooses between a foregone-interest cost of cash and a time cost of credit when purchasing any one good. Avoiding the inflation tax means switching from fiat that uses no resources to exchange credit that uses up societal resources.[...]the consumer substitutes away from cash until the marginal cost of avoiding inflation, through credit use, equal the marginal inflation tax on cash use". The increase in the nominal interest rate makes more costly to hold money. Agents thus switch to an alternative -inflation free- medium of exchange. The credit to money ratio increases with inflation. In a world where money and credit are complementary -i.e. with debt repaid in cash- rather than substitute the effect of inflation on credit is reversed. When agents are sufficiently impatient -i.e. when $\beta < \left(\frac{1}{4}\frac{1}{1+\pi}\right)^{\frac{1}{3}}$- the participation constraint is binding and output is independent of inflation and equal to $2\beta^2$.

In equilibrium, each period one third of the population is consuming using both money and credit, one third is producing for money and credit and one third is resting while repayment takes place. One third of agents j in the morning - period t- are on island j and trade money for goods. They also issue promises secured by the collateral to increase their consumption of good j. Then they travel to island $j+1$. In the afternoon - period $t+1$- they produce for money and for promises. They repay their promise in the afternoon, handing fiat money to their creditors (agents $j-1$) who have travelled with them and are waiting on island $j+1$. The collateral is returned and promises destroyed. In the evening they leave to island $j+2$ where they rest and wait for repayment to take place. Finally they travel to island j to restart the cycle. Money and credit are both media of exchange and money is the means of payment. For this to be an equilibrium, agents shouldn't want to deviate. When an agent is consuming, it is fairly intuitive that he wants to use both money and credit since they allow him to transact and consume more. When an agent is producing though, several possible deviations have to be considered. First, he may refuse to repay his debt. In this case he would loose his collateral, would be unable to consume in the future and would thus get zero for ever. This possibility is already captured by the participation constraint: when agents are patient enough they prefer to repay and get their collateral back rather than loosing it. Second, he could repay his debt, but then produce for money instead of lending. This deviation would be particularly attractive if the agent could spend his cash immediately and consume. The mismatch between the arrival of liquidity and consumption opportunities makes it attractive to lend in order to gain positive interest. The equilibrium interest rate makes agents willing to lend. Consider then the possibility to repay debts with someone else's promise instead of money. In this case the original issuer of the promise may not meet the holder of his collateral again since agents, once they are on an island, are matched randomly and there is a continuum of them[9]. Agents wouldn't issue promises in the first place and this is enough to rule out the deviation. Notice finally that the lack of double coincidence of wants excludes repayment with commodities. The two media of exchange coexist in a fundamental sense: each agent uses both at every stage to exchange.

3.1 Credit, Output and Real Interest Rate

Here I will discuss the implications of anticipated inflation for credit, output and the real interest rate. First, inflation harms credit. In the afternoon the lender holds a claim to future money which will be paid off in the evening. He will then have to hold money overnight, until the next morning when he will be able to spend it to buy consumption goods. Inflation drives up the nominal interest rate and makes it costly to hold claims to future money: agents reduce their credit holdings. Therefore, the amount produced for credit as a share of output is decreasing in the inflation rate

$$\frac{y^C}{y} = \frac{\beta^{\frac{3}{2}}}{\beta^{\frac{3}{2}} + (1+\pi)^{\frac{1}{2}}}$$

Boyd, Levine and Smith (2001) find evidence of a negative relationship between private credit to GDP and inflation, using both cross-country and panel data for around 60 countries between 1960 and 1995. Second, output is decreasing in the inflation rate.

[9] Technically it is a zero measure event.

Credit increases the amount of transactions which, in turn, increases output. Higher inflation reduces the credit to money ratio and this reduces transactions and the incentives to produce.

$$y = \frac{1}{\beta}\left(\frac{y^C}{y^M}\right) = \left(\frac{\beta}{1+\pi}\right)^{\frac{1}{2}}$$

This happens when the inflation rate is sufficiently high -i.e. for $\pi \geq \frac{1}{4\beta^3} - 1$. For lower inflation factors output is insensitive to inflation. "There is now a substantial body of evidence indicating that sustained -and, therefore, likely predictable- high rates of inflation can have adverse consequences either for an economy's long-run rate of real growth or for its long-run level of real activity." (Boyd, Levine and Smith (2001)). In a recent paper, Stanley Fischer, Ratna Sahay and Carlos Vegh highlight the fact that in high inflation countries credit and output have been severely harmed by inflation. Interestingly, Bullard and Keating (1995) find evidence that output is relatively insensitive to low inflation rates and decreasing for higher inflation rates. Third, the real interest factor increases with the inflation rate

$$(1+r) = \frac{1+i}{1+\pi} = \frac{(1+\pi)^{\frac{1}{2}}}{\beta^{\frac{3}{2}}}$$

In the model the creditor is bearing the cost of inflation, since he is holding money for one period while he is resting. The higher interest rate compensate him for the cost of holding money in the presence of inflation. Changing slightly the model, it would be possible to make the debtor hold money for one period. The analysis would go through unchanged except for the real interest rate which would be decreasing in inflation. In this case it would be the debtor who would have to be compensated for holding money in the presence of inflation. What is really crucial is therefore that the real interest rate changes with inflation -and thus the nominal interest rate is not unit elastic in inflation- rather than the direction of the change. The mismatch between the arrival of liquidity and of consumption opportunities is responsible for the break-down of the Fisher effect. Koustas and Serletis (1999) document empirically the failure of the Fisher effect.

Complementarity between money and credit in the model is represented by the repayment constraint which is responsible for the effects of inflation on credit, on output and on the interest rate[10]. Anticipated inflation gives rise to a reverse Mundell-Tobin effect: the credit to output ratio and output decrease with inflation and the real interest rate increases with inflation.

3.2 Welfare

As a measure of welfare consider the sum of the utilities of the three types of individuals in equilibrium: consumers, producers and resting agents.

$$W(\pi) = \frac{2\beta^{\frac{1}{2}}(1+\pi)^{\frac{1}{2}} - \beta}{2(1-\beta)(1+\pi)}$$

Inflation drives down the credit to money mix in the economy, thus reducing output and welfare. Welfare is decreasing in the inflation rate for any $\pi \geq 0$:

$$W'(\pi) = \frac{\beta^{\frac{1}{2}}\left[\beta^{\frac{1}{2}} - (1+\pi)^{\frac{1}{2}}\right]}{2(1-\beta)(1+\pi)^2} < 0$$

The literature typically identifies the welfare costs of inflation with the resource cost of producing transaction services alternative to cash. Resources are diverted from production to credit services and welfare is lower. "In a monetary economy, it is in everyone's private interest to try to get someone else to hold non-interest-bearing cash and reserves. [...] All of us spend several hours per year in this effort and we employ thousands of talented and highly-trained people to help us. These person-hours are simply thrown away, wasted on a task that should not have to be performed at all." (Lucas (2000)). The model provides an additional source of the welfare cost of inflation.

The optimal monetary policy would be the Friedman Rule. The government should tax money balances, deflating at a rate $\pi = \beta - 1$, to correct the distortion due to market incompleteness and achieve the first best allocation. However, the Friedman Rule cannot be implemented through lump-sum taxes since enforcement is limited in the economy and agents cannot be forced to surrender money to the government.

The economy with credit always performs better than the corresponding economy without credit. Money and credit achieve a socially preferred outcome. The combination

[10] In Stockman (1981) a cash constraint on investment gives rise to similar effects.

of the two means of exchange allows the economy to move closer to the first best frontier. Money helps credit to work providing the means of payment and the use of credit improves output and welfare compared to an economy without credit.

4 Conclusion

I addressed the issue of the role of money as a means to repay debt, considering an environment where money and bilateral credit can be used as media of exchange. Money serves as the means of payment and credit allows agents to transact more. Debtors will have to hold cash in the future in order to repay their debts. Attanasio, Guiso and Jappelli (2002) estimate a money demand function based on the Baumol-Tobin model with time, interest on checking accounts and consumption as explanatory variables. The model suggests that debt might also have a role in determining agents' demand for cash. Anticipated inflation increases the real interest rate and decreases credit, output and welfare.

References

[1] Attanasio, Guiso and Jappelli (2002), The demand for money, financial innovation, and the welfare cost of inflation: an analysis with household data, *Journal of Political Economy*, 110, 21, 317-351.

[2] Boyd, Levine and Smith (2001), The Impact of Inflation on Financial Sector Performance, *Journal of Monetary Economics*, 47(2), 219-446

[3] Bullard and Keating (1995), The Long-run Relationship between Inflation and Output in Post-war Economies, *Journal of Monetary Economics*, 36, 477-496

[4] Fischer, Sahay and Vegh (2002), Modern Hyper and High Inflations, *Journal of Economic Literature*, 40(3), 837-880.

[5] Freeman (1996), The Payments System, Liquidity, and Rediscounting, *The American Economic Review*, 86, 1126-1138.

[6] Gillman (1993), The Welfare Cost of Inflation in a Cash-in-advance Economy with Costly Credit, *Journal of Monetary Economics*, 31, 97-115.

[7] Goodhart (1989), *Money, Information and Uncertainty*, Macmillan, London.

[8] Green (2002), Payment Arrangements and Inflation, *The American Economic Review*, 92(2), 51-58.

[9] Kiyotaki and Wright (1989), On Money as a Medium of Exchange, *Journal of Political Economy*, 97(4), 927-954.

[10] Kocherlakota (1998), Money is Memory, *Journal of Economic Theory,* 82, 232-251.

[11] Kocherlakota and Wallace (1998), Incomplete Record-keeping and Optimal Payment Arrangements, *Journal of Economic Theory,* 81, *272-289.*

[12] Koustas and Serletis (1999), On the Fisher Effect, *Journal of Monetary Economics*, 44, 105-130.

[13] Lucas (2000), Inflation and Welfare, *Econometrica*, 68, 247-274.

[14] Shi (1996), Credit and Money in a Search Model with Divisible Commodities, *Review of Economic Studies*, 63, 627-652.

[15] Stockman (1981), Anticipated Inflation and the Capital Stock in a Cash-in-Advance Economy, *Journal of Monetary Economics*, 8, 387-393.

[16] Tobin (1965), Money and Economic Growth, *Econometrica*, 33, 671-810.