Money is an Experience Good:

Competition and Trust in the Private Provision of Money.*

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Abstract

We study the interplay between competition and trust as efficiency-enhancing mechanims in the private provision of money. With commitment, trust is automatically achieved and competition ensures efficiency. Without commitment, competition plays no role. Trust does play a role but requires a bound on efficiency. Stationary inflation must be positive and, therefore, the Friedman rule cannot be achieved.

The quality of money can only be observed after its purchasing capacity is realized. In that sense money is an experience good.

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1 Introduction

Can currency be efficiently provided by competitive markets? A traditional *laissez-faire* view – as, for example, has been expressed by Hayek – based on "Bertrand competition" argues that competition drives the price of money to its marginal cost. Therefore, if the marginal cost of producing currency is zero, competition drives nominal interest rates to zero and private provision of currency is efficient.

We show that there is a major flaw in this "Bertrand competition" argument, when applied to fiat money: If suppliers of currency cannot commit to their future actions, then competition loses its bite. The reason for this is that, while currencies compete on their promised rates of return, once agents hold a particular currency there may be an incentive for the issuer to inflate the price of goods in terms of this currency, reducing, in this way, the outstanding liabilities. Current currency portfolios have been pre-specified, while there is full flexibility to choose tomorrow's portfolios. Currencies compete for tomorrow's portfolios. When choices are sequential, currencies are no longer perfect substitutes; in a sense, they are not substitutes at all. Does "Bertrand competition" still drive promised rates of return to the efficient level? Not if those promises are not credible, if issuers of currencies are not trusted.

Trust may resolve the time inconsistency problem in the supply of money, since concern for the future circulation of money may deter currency issuers from creating inflation. Nevertheless, reputation concerns exist as long as currency suppliers expect sufficiently high future profits to refrain from capturing the short-term profits. Does competition, by driving down profits, enhance efficiency but also destroy the disciplinary properties of the "trust mechanism"? We show that there is no such trade-off. Without commitment, competition plays no role in sustaining efficient outcomes.

We analyze a model of currency competition (section 2) where goods are supplied in perfectly competitive markets, and consumers can buy these goods by using any of a continuum of differentiated currencies. Each currency is supplied by a profit maximizing firm. Even though the currencies are imperfect substitutes, by making the degree of substitutability arbitrarily large we can characterize the limiting economy of perfect substitution among currencies. With commitment, currency competition achieves the efficient (Friedman rule) monetary equilibrium, as Hayek had envisioned. The Friedman rule condition of zero nominal interest rates implies that inflation

will be negative on average, since real interest rates are on average positive. Currency issuers will have to be withdrawing money from circulation, which means that cash flows will be negative. Even if the total revenues from currency issuance, including the gains from the initial issuance may be positive, in each period they will be losing money. In order for this to be an equilibrium, currency issuers must be able to commit to future losses.

Without commitment, negative inflation cannot be sustained. But, as it turns out, every stationary positive inflation is an equilibrium. And the degree of substitutability does not affect this characterization. These are the main results of the paper, *i)* the existence of a bound on efficiency defined by the need to 'sustain trust', *ii)* that the bound of efficiency corresponds to inflation being positive, and *ii)* an indeterminacy of expectations sustaining trust that may result in competition playing no role.

These results apply to other markets where goods or services must be purchased before their quality can be observed. Those goods are called experience goods. There is a sense in which money is also an experience good. We can think of the quality of money as the amount of goods that money can buy, the real value of money, which can only be observed ex-post. The provision of money and the provision of experience goods seem a priori very different problems (the former being an information problem and the latter a commitment problem), but they are indeed isomorphic regarding the interplay between competition and trust. While the elasticity of substitution for high quality goods can be quite high, once the goods have been purchased the elasticity is zero. A supplier that does not take into account reputational concerns will only consider this elasticity, and will not supply high quality goods or services. Still, in a dynamic economy, firms are concerned for their future market position, so that reputation may be enough to discipline firms to effectively provide high quality goods. The mechanism that can sustain high quality (and possibly low prices) is reputation, not competition. This analogy is discussed in section 3.

The issue of currency competition has been the subject of an extensive academic debate. This debate has seen many supporters of free competition making an exception when it comes to money (Friedman, 1960), while advocates of free currency competition (notably, Hayek (1974 and 1978), and Rockoff, 1975) have been somewhat isolated. In spite of this, the relatively recent reappraisal of the self-regulating properties of free banking[1] has raised

[1]See, for example, Calomiris and Kahn (1996), Dowd (1992), King (1983), Rolnick and

new interest in the study of currency competition.

The problem of time-inconsistency of monetary policies has been extensively studied since Calvo (1978)[2], but with the partial exceptions of Klein (1974) and Taub (1985 and 1986), the currency competition argument has not been considered. Klein understood that the problem of currency competition could not be studied independently of the time inconsistency problem. Like Shapiro (1983), he postulated ad-hoc beliefs, so the way competition and reputation interplay in determining equilibrium outcomes is not analyzed. He raised some of the questions we address in this paper but without a full characterization as we do here. Taub (1985) studies two distinct regimes: one with full commitment with non-stationary ("time-inconsistent") policies, and another in which polices are constrained to be "time-consistent" (stationary). He shows that in the commitment case, the Friedman rule emerges as the competitive outcome, while in the "time-consistent" case the outcome is inefficient and, as a result, he argues in favor of the "natural monopoly" argument. While we have the same result when there is full commitment, our analysis of the "non-commitment case" differs substantially. Taub (1986) considers the problem of currency competition in a model in which the government can commit for a given number of periods. He obtains results that are similar to ours, although in our model what prevents firms from choosing fly-by-night strategies is endogenous reputation, rather than exogenous commitment.

Marimon, Nicolini and Teles (2003) analyze the effects of electronic money, and other currency substitutes, on monetary policy. The suppliers of inside money must use an inefficient technology, relative to the provision of outside money, but are not subject to the time inconsistency problem that the supplier of outside money faces. Competition from inside money does play a role in this context. Improvements in the technology to supply inside money, do bring equilibrium inflation down. In this paper we are interested in analyzing competition in the provision of outside money, and therefore the time inconsistency problem is shared by all the suppliers.

An interesting application of the analysis in this paper is to competition in the supply of reserve currencies. For the issuer of a reserve currency

Weber (1983), Selgin (1987), Selgin & White (1987), Vaubel (1985), and, more generally, White (1993) . See also Schuler (1992), for an account of historical episodes of free banking, Hayek (1974,1978), Dowd (1992) and White (1993).

[2]See, for example, Chang (1998), Chari & Kehoe (1990), Ireland (1994) and Stokey (1991).

with commitment there is a level of inflation that maximizes seigniorage revenues from nonresidents. The benevolent Ramsey planner will have to weigh those gains with the costs of distortionary inflation affecting resident agents. The resulting inflation rate could be reasonably high. Schmitt-Grohe and Uribe (2010) compute the optimal inflation rate for the US dollar and conclude that this could be the justification for observed deviation from the Friedman rule. Taking our approach, we would add that competition with alternative providers of a reserve currency, such as the Euro, would imply different equilibrium outcomes. Under commitment, Bertrand competition would bring inflation down back to the Friedman rule. Without commitment, again any positive inflation would be sustainable if seigniorage revenues from non residents were the only objective of currency issuers.

2 A model of currency competition

We consider an economy with a large number of identical households that draw utility from a single consumption good, c_t, and disutility from work effort, n_t. The utility function of the representative household is

$$\sum_{t=0}^{\infty} \beta^t \left[U(c_t) - \alpha n_t \right], \tag{1}$$

where U is increasing and concave and, without loss of generality, $U(0) = 0$, α is a positive constant. The technology is linear in labor, with a unitary coefficient, so

$$c_t = n_t.$$

We allow for free entry into the production of the good, so that firms will make zero profits in equilibrium and the price of consumption in terms of labor will be one.

We assume that consumers must buy the consumption good with a composite of the continuum of all possible differentiated currencies. This composite money aggregate is defined as

$$m_t = \left[\int_0^1 m(i)_t^{1/\mu} di \right]^{\mu}, \ \mu > 1$$

where $m(i)_t$ is the real value of type i money, used for transactions at time t. The monies are imperfect substitutes but we consider imperfect substitutability only as a methodological device to study the limiting economy

where substitutability is arbitrarily large. In the limit each of the monies is general purchasing power. This model is a natural framework to analyze Hayek's conjecture that money can be supplied efficiently by the market, and, as such, it contains interesting implications for monetary theory.

We analyze the limiting economy as the degree of substitutability is arbitrarily large instead of the case of perfect substitutability because it is a natural way of dealing with the indeterminacy of money demands that arises when the monies are perfect substitutes.

The representative consumer maximizes utility subject to the following budget constraint

$$b_{t+1} + \int_0^1 \frac{M(i)_{t+1}}{P(i)_t} di + c_t \leq n_t + b_t(1 + r_t) + \int_0^1 \frac{M(i)_t}{P(i)_t} di + \Pi_t, \ t \geq 0$$

where $P(i)_t$ is the price of the consumption good in units of money i and $M(i)_t$ is the quantity of money i, held from time $t-1$ to time t, and used for transactions at time t, so that $m(i)_t = \frac{M(i)_t}{P(i)_t}$. $\Pi(i)_t$ are the current profits of the provider of currency i in units of the consumption good, $\Pi_t = \int_0^1 \Pi(i)_t di$. Every period t, the consumer purchases $M(i)_{t+1}$ of currency i and real bonds b_{t+1} that pay the real interest rate r_{t+1} in period $t+1$. $M(i)_0$ and b_0 are given. This budget constraint can be written as

$$b_{t+1} + \int_0^1 m(i)_{t+1}(1 + \pi(i)_{t+1}) di + c_t \leq n_t + b_t(1 + r_t) + \int_0^1 m(i)_t di + \Pi_t, \ t \geq 0 \tag{2}$$

where $\pi(i)_{t+1} = \frac{P(i)_{t+1}}{P(i)_t} - 1$.

The cash-in-advance constraint is

$$c_t \leq m_t = \left[\int_0^1 m(i)_t^{1/\mu} di \right]^{\mu} \tag{3}$$

for all t.

Let $R(i)_{t+1}$ be the gross nominal interest rate from time t to $t+1$ on money i, so that $R(i)_{t+1} \equiv (1 + r_{t+1})(1 + \pi(i)_{t+1})$, and let

$$R_{t+1} - 1 \equiv \left[\int_0^1 (R(i)_{t+1} - 1)^{\frac{1}{(1-\mu)}} di \right]^{1-\mu}$$

Then, the first order conditions of the consumer's problem imply:

$$U'(c_{t+1}) = \alpha R_{t+1},\ t \geq 0$$

$$m(i)_{t+1} = \left(\frac{R(i)_{t+1} - 1}{R_{t+1} - 1}\right)^{\frac{\mu}{1-\mu}} m_{t+1},\ t \geq 0 \tag{4}$$

$$r_{t+1} = \frac{1}{\beta} - 1 \equiv \rho,\ t \geq 0$$

The flow of funds constraint of the issuer of currency i is given by

$$\frac{M(i)_{t+1}}{P(i)_t} + d(i)_{t+1} = \frac{M(i)_t}{P(i)_t} + d(i)_t(1+\rho) + \Pi(i)_t$$

where $d(i)_{t+1}$ is the debt issued by the i-currency issuer at time t, in units of the consumption good, and $\Pi(i)_t$ are the profits of the money issuer in units of the consumption good. $M(i)_0$ and $d(i)_0$ are given. It also faces the corresponding non-Ponzi constraints guaranteeing that the present value budget constraint is well defined. The present value of profits is

$$\sum_{t=0}^{\infty} \beta^t \Pi(i)_t = \sum_{t=1}^{\infty} \beta^t \left(\left(R(i)_t - 1\right) m(i)_t\right) - \frac{M(i)_0}{P(i)_0} - \frac{d(i)_0}{\beta}. \tag{5}$$

2.1 Equilibria with commitment

As in standard (single currency) monetary models, a monetary policy for the i-currency issuer consists of a current price level and a sequence of future nominal interest rates, $(P(i)_0, \{R(i)_t\}_{t=1}^{\infty})$.

In order to maximize the present value of profits (5), firms must choose $R(i)_t$ to maximize

$$\left(R(i)_t - 1\right) m(i)_t$$

taking the demands for currency (4) as given. Optimality also requires that the real value of initial outstanding money holdings (liabilities for the issuer) become zero, $\frac{M(i)_0}{P(i)_0} = 0$. This means that the initial price level would be arbitrarily high, as long as $M(i)_0 > 0$, so that the price level must be defined in the extended reals.[3] This is achieved through a big open market operation

[3]This is a technical assumption that allows us to deal with infinite price levels, and also infinite growth rates of those prices. This is in line with the literature on optimal monetary policy, with and without commitment, such as Calvo (1978) and Lucas and Stokey (1983).

in which the currency is sold back to the consumers. Each currency issuer takes a negative position in bond holdings, in an amount equal to the real quantity of money. In subsequent periods, the currency issuer collects the real rate of interest on those assets, as well as the inflation rate on real money holdings, corresponding to future money issuing.

The maximization of $(R(i)_t - 1)\, m(i)_t$ subject to (4), results in the choice

$$R(i)_t = \mu,$$

corresponding to a stationary finite level of real money $m(i)_t = m$, such that

$$U'(m) = \alpha\mu$$

The value of the parameter μ determines the substitutability of the currencies. The closer is μ to one, the higher is the degree of substitutability. As currency substitution increases, i.e., $\mu \searrow 1$, nominal interest rates tend to zero, i.e., $(R(i)_t - 1) \searrow 0$, which is supported by a deflationary monetary policy, i.e., $\pi(i)_t \searrow (\beta - 1)$. In other words, with perfect substitution of private currencies the monetary equilibrium is efficient and the Friedman rule is implemented. Thus, with full commitment, Hayek's conjecture, that efficient monetary equilibria can be achieved through currency competition, is verified.

Nevertheless, as in standard (single currency) monetary models, the full commitment policy is time inconsistent. This can easily be seen by considering how the present value of profits of a currency issuer evolves over time. At time t, this is

$$\sum_{j=t}^{\infty} \beta^{j-t} \Pi(i)_j = \sum_{j=t+1}^{\infty} \beta^{j-t} \left((R(i)_j - 1) m(i)_j \right) - \frac{M(i)_t}{P(i)_t} - \frac{d(i)_t}{\beta}. \qquad (6)$$

Thus, if given the option to change plans at time t,which we rule out when assuming full commitment, the currency issuer will find it optimal to let $\frac{M(i)_t}{P(i)_t}$ be zero. The reason is that the real money demand is decreasing in the nominal interest rates, i.e., in expected future price levels. However, once consumers have made their currency decisions, the nominal money demand is predetermined and therefore it is rigid with respect to the current price level. We turn now to analyze the case without commitment.

2.2 Currency competition without commitment

With full commitment, there is no distinction between ex-ante and ex-post nominal interest rates. We were able to specify the decisions of the currency issuer in terms of the whole sequence of ex-ante nominal interest rates, $\{R(i)_t\}_{t=1}^{\infty}$, that depend on the realization of future prices. Without commitment, that cannot be done. We have to define the strategies of the currency issuer in terms of realized, ex-post nominal interest rates. We define these as $R^q(i)_t = (1+\rho)(1+\frac{P(i)_t}{P(i)_{t-1}})$.

Firms maximize short run profits by setting an arbitrarily large price, $P(i)_t$, or an arbitrarily large, ex-post nominal interest rate, $R^q(i)_t$. This corresponds to inflating away current money holdings (i.e., in making "the quality of outstanding money" arbitrarily low). Consumers purchase monies before they observe the real return they yield, and must form their expectations on future prices, based on past information and current prices. Reputation is what may prevent firms from "flying-by-night."

Currency issuers choose[4] $R^q(i)_t = (1+\rho)(1+\frac{P(i)_t}{P(i)_{t-1}})$, except for the first period, since $P(i)_{-1}$ is not defined. Because the price level can be made arbitrarily large, the ex-post nominal interest rate is in the extended reals, $R^q(i)_t \in [1,\infty) \cup \{\infty\}$.

Histories are given by $h_{-1} = \{\emptyset\}$, $h_0 = \{h_{-1}, P(i)_0\}$ and $h_t = \{h_{t-1}, R^q(i)_t, \text{ all } i\}$, for $t \geq 1$. The i-currency issuer strategy is given by

$$\begin{aligned} \sigma^b_{i,0}(h_{-1}) &= P(i)_0, \text{ and} \\ \sigma^b_{i,t}(h_{t-1}) &= \lambda_{i,t}, \text{ for } t \geq 1 \end{aligned}$$

where $\lambda_{i,t}$ is a density function on R^+, such that $\lambda_{i,t}(h_{t-1}; R^q(i)_t)$ is the density of $R^q(i)_t$, conditional on h_{t-1}.[5]

Consumers behave competitively, deciding according to the allocation rule $\sigma^c = \{\sigma^c_t(h_t)\}_{t=0}^{\infty}$, where $\sigma^c_t(h_t) = \{c_t, n_t, \ b_{t+1}, M(i)_{t+1}, \text{all } i\}$, for $t \geq 0$, based on υ^i_t - their beliefs about future decisions of the currency issuers - and corresponding prices. $\upsilon^i_t(h_t; R^q(i)_{t+1})$ denotes the assessed density of the ex-post interest rate $R^q(i)_{t+1}$. Notice that we implicitly assume that beliefs about firm i do not depend on other firms' prices. Rational expectations

[4]Note that given a history, picking the price level at time t, is equivalent to picking the ex-post nominal interest rate.

[5]Since issuers decide on $P(i)_0$ before consumers make any decision, there is no need to introduce mixed strategies on that decision.

requires that beliefs are consistent with currency issuers strategies,[6]

$$\upsilon_t^i(h_t; R^q(i)_{t+1}) = \lambda_{i,t+1}(h_t; R^q(i)_{t+1})$$

A *Sustainable Currency Competition Equilibrium* (SCCE) consists of $\left((\sigma^c, \upsilon^i), (\sigma_i^b)\right)$, such that,

1. for every (t, h_t), $\sigma_{i,t}^b(h_{t-1})$ solves the maximization problem of the i-currency issuer;

2. $\sigma_t^c(h_t)$ solves the consumer's problem given consistent beliefs $\upsilon_t^i(h_t; R^q(i)_{t+1})$,

3. and all markets clear.

A *Sustainable Currency Competitive Equilibrium* provides a natural framework to study the interactions between competition and trust. On the one hand, as long as μ is strictly larger than one, the economy exhibits monopolistic power, and as μ gets close to one, the competition between issuers is increased. On the other hand, the beliefs of the consumers depend on the firms' actions. In this sense, the firms care about their reputation.

In what follows, we restrict attention to *symmetric equilibria* in the sense that all firms behave the same way in equilibrium.

Let us consider an equilibrium where strategies do not depend on histories. If current (time t) actions of the issuers of currency do not affect the consumers' expectations about future actions, then it is a dominant strategy for the issuer of each currency to choose $R^q(i)_t = \infty$, for every $t \geq 1$. At $t = 0$, $P(i)_0 = \infty$. It follows that the currency will not be held, $m(i)_{t+1} = 0$, $t \geq 0$. The resulting payoff for the issuer is $-\frac{d(i)_0}{\beta}$. The issuers can guarantee themselves this payoff, independently of the beliefs, so that this is *the worst SCCE*. More formally,

Proposition 1 *There exist* low quality SCCE, *supported by strategies* $P(i)_0 = \infty$, *and* $\lambda_{i,t}(h_{t-1}; \infty) = 1$, *and beliefs* $\upsilon_t^i(h_t, \infty) = 1$, *with corresponding allocations. Furthermore, there is no SCCE with lower payoffs for the currency issuers.*

[6]Note that at time t, consumer's care about future monetary policy, that is why time t beliefs ought to be the same as firm's strategies at $t + 1$.

Incidentally, note that this is the unique SCCE (payoff) in which strategies do not depend on histories. In this case no issuer is ever trusted to provide high quality money. This would be the unique outcome if issuers were anonymous players not accountable for their past decisions.

We check now whether a stationary gross nominal interest rate, $R = R(i)$, is sustainable as a SCCE. In order to check this, we consider the standard trigger strategies of reversion to the worst SCCE strategies. Suppose that the i-currency issuer considers a deviation in period $t > 0$, letting $R^q(i)_t \to \infty$, by printing arbitrarily large amounts of money. Suppose that agents' expectations are such that, after observing that the *ex-post* rate differs from the equilibrium outcome R, they become $v^i_{t+s}(h_{t+s}; R^q(i)_{t+1+s} = \infty) = 1$, for any h_{t+s}, $s \geq 0$. Given such beliefs, real money demand for that currency is zero from time t on, i.e., $m(i)_{t+s} = 0$, $s \geq 0$, which means that the newly issued pieces of paper are worthless.

The value of the outcome after the deviation is zero, except for the value of the outstanding real debt. The reason is that the deviation triggers a currency collapse for that currency, starting tomorrow. The demand for money, being an asset, depends on future prices. Thus, the expectations of the currency collapse make the newly injected money be worthless today. Therefore, the present value of the benefits following a deviation is obtained by replacing the real value of money from time t on by zeroes in the expression for profits (6)

$$V^D(i)_t = -\frac{d(i)_t}{\beta}$$

On the other hand, if the issuer does not deviate, the present value of the profits are

$$\begin{aligned} V^C(i)_t &= \beta\frac{(R(i)-1)m(i)}{1-\beta} - \frac{M(i)_t}{P(i)_t} - \frac{d(i)_t}{\beta} \\ &= \rho^{-1}(R(i)-1)m(i) - m(i) - d(i)_t\beta^{-1} \end{aligned}$$

The last equality follows from the fact that, in equilibrium, $m(i) = \frac{M(i)_t}{P(i)_t}$. It follows that the i-currency issuer will choose not to deviate when

$$\left[\rho^{-1}(R(i)-1) - 1\right] \geq 0,$$

$$\text{i.e., } R(i) \geq 1 + \rho$$

or, equivalently, whenever $\pi(i) \geq 0$. More formally,

Proposition 2 *$\pi(i) = \pi$ is an outcome of a stationary symmetric SCCE iff $\pi \geq 0$.*

An equilibrium path with symmetric stationary policies is sustainable if and only if the corresponding inflation rates are positive. The reason why inflation must be positive is because of the timing of collection of revenues for the issuers. The issuers of currency lend the initial money balances to the households. Thus, they hold positive assets in an amount equal to the real value of those balances. From those assets they collect the real rate of interest, ρ. Thereafter, they also collect the inflation rate times the real money balances every period. If they deviate, they will keep the real asset holdings only.[7] Thus, as long as the returns they make with the inflation tax are non-negative, they have no incentives to deviate. In other words, future profits must be sufficiently high, and, in this monetary environment, future profits are the gains from future issuance of money. The gains corresponding to the initial issuance of money, the real rate on the real money stock, are sunk.

In summary, without full commitment, Hayek's conjecture, that efficient monetary equilibria can be achieved through currency competition, is not verified, as long as optimality requires deflation in equilibrium, as in Friedman´s rule.

The Friedman rule, of a zero nominal interest rate is associated with deflation if $\rho > 0$. The discount rate ρ does not affect the condition on inflation for sustainability. However it does affect efficiency of the lowest inflation equilibrium. The lower is ρ, the closer is zero inflation to the efficient outcome. Now does this mean that if the time period was smaller, it would be possible to sustain more efficient outcomes? No, that is certainly not the case. We have considered that velocity is one. By doing that we have pinned down the length of the time period. Because velocity relates the stock of money with the flow of consumption, the shorter is the time period the lower is velocity. In the limit as the time period goes to zero, while the stock of money remains constant, the flow of consumption converges to zero, and so does velocity. At zero velocity, even a very small nominal interest rate would mean an arbitrarily large cost of using money. In a continuous time model, when inflation is zero, the nominal interest rate is equal to the instantaneous

[7]Note that if the issuer were forced to hold their own currency denominated assets, then the efficient outcome could be supported as a SCCE.

discount rate. The monetary distortion is invariant to the length of the time period.

3 Money is an experience good

The private provision of currencies is by no means the only case where producers compete for promises and the standard "Bertrand competition" argument does not apply. Competition in experience goods - those whose quality can only be revealed by consuming the good - has similar properties, since firms have an incentive to "fly-by-night" providing low quality products[8]. "Bertrand competition" can only affect market prices, but not the qualities which are observed only *ex-post*.

To be more specific, suppose that, instead of monopolistic competitive issuers of currency, firms supplied final goods also under monopolistic competition. Suppose the production function was linear with a unitary coefficient. Assume also that producers have, at any time, the option of producing "fake" units of the consumption good that are costless to produce and deliver no utility to the buyer. A key assumption for the characterization of the equilibria is whether consumers can distinguish the high quality goods from the low quality ones before they buy them.

If the quality of the goods is perfectly observable before buying, the equilibrium is uniquely determined: The price chosen by each monopolist is determined by the elasticity of substitution. As goods become closer substitutes, the equilibrium outcome becomes more efficient. It is Pareto efficient in the limiting case of perfect substitution.

Imagine, instead, that the quality is only observed with a lag. In a dynamic economy, firms are concerned for their future market position and this may be enough to discipline them and effectively provide high quality goods. Given that the firm has the option of making a short run profit by selling low quality goods, the equilibrium mark-up must be high enough so that the firm choses not to excercise it. The equilibrium mark up is not determined by the elasticity of substitution as in the case of perfect observability. Rather, it is determined by the need to guarantee enough future profits to ensure high

[8]Shapiro (1983) considers a model of monopolistic competition in which consumers' expectations regarding quality follow an ad-hoc exogenous process. He does not study the trade-offs between competition and reputation.

quality. Increasing the degree of substitutability does not affect the set of equilibria, and competition plays no role.

Thus, while the provision of money and the provision of experience goods seem a priori very different problems, the former being a 'moral hazard problem' and the latter a 'time inconsistency problem' the ways in which competition and trust interact are strikingly similar. In both models firms compete in prices that are not observable or that they cannot commit to: In the quality-goods model, this is the price of the good per unit of quality; in the currency competition model it is the nominal interest rate, or the inflation rate. With perfect observability in the first model and with full commitment in the second, there is no distinction between set and realized prices. With unobservable quality in the first model and lack of commitment in the second, we have to consider off-equilibrium paths where the *ex-post* realized prices may differ from the *ex-ante* prices. In such cases, firms maximize short run profits by setting an arbitrarily large realized price, which in the experience good model corresponds to choosing low quality and in the currency model corresponds to inflate away current money holdings (i.e., in making "the quality of outstanding money" arbitrarily low). In both models, the timing is very important: Consumers purchase services before they observe the quality they yield, in one, and they purchase monies before they observe the real return they yield, in the other; in both models, consumers must form their expectations on realized prices, based on past information and current prices, and, in both models, reputation is what may prevent firms from "flying-by-night."

4 Robustness

In the monetary model of currency competition that we have analyzed, in any time period, there are two relevant elasticities of substitution. On one hand, the holder of currency will be considering alternative currencies to hold in the future. The opportunity cost of holding each currency is the future return on interest bearing assets denominated in that currency. The elasticity of substitution could be quite high, possibly arbitrarily large. On the other hand, currency holders also hold outstanding money balances. Those balances are whatever they are, they cannot be changed. On these outstanding money balances, the elasticity is zero. For the currency issuer, the elasticity of substitution that is relevant for current decisions is zero, while the elasticity of

substitution that is relevant for future decisions is positive, it could even be infinite.[9] With commitment, the issuer of currency will always want to exploit the initial period zero elasticity, and inflate away those initial liabilities. In addition, then there will be competition in nominal interest rates, and the outcome will clearly depend on the elasticity for future money holdings. In particular, if the elasticity is arbitrarily large, then, equilibrium outcomes will be efficient.

Instead, if the currency issuer is unable to commit to future decisions, then competition in nominal interest rates is meaningless. The relevant elasticity of substitution that it faces is zero, period after period. If reputational considerations are not taken into account, then the issuer will always want to act on the zero elasticity, and the only equilibrium is one where money has no value. Beliefs about future actions, because future profits can be high enough, may discipline the issuer of money, and there could be equilibria where actual inflation is not arbitrarily large. This mechanism is independent of the elasticity of substitution for future holdings, and therefore in our framework, it is independent of competition. Without commitment, competition plays no role in ensuring efficieny.

We make these points in a model where there is a fixed number of firms, a continuum of those, that compete under monopolistic competition. It is clearly a very particular set up. Now, is it the case, that alternative models of competition would affect the results? How general are the results?[10]

In the case of commitment, the particular model of competition will affect the results in all the usual ways. If the number of firms was finite, it would be important if competition was Bertrand or Cournot. And, the number of firms would matter. If the number of firms was endogenous, and there was free entry, as in Salop(1979) circular-city model, this would also affect the commitment results.

Instead, without commitment, as it turns out, the results are quite general. Whatever is the form of competition, the elasticity on the outstanding money balances will always be zero, and regardless of future elasticities, or strategic interactions, there will always be an equilibrium where the issuers

[9]In a related literature (see Phelps and Winter (1970), Diamond (1971), Bils (1989), Nakamura and Steinsson, 2009) firms face different short and long run elasticities, possibly because of habits. In such a context, firms' decisions are also time inconsistent. However, because the short run elasticity is not zero, as it in our case, the short run elasticity will matter for the characterization of equilibria without commitment.

[10]We thank the comments of the referee who raised the questions that led to this section.

will take into account only the short run gains, resulting in beliefs that will not sustain valued money. This will be the worst sustainable equilibrium. Alternative sustainable equilibrium outcomes will be constructed by reversion to the worst sustainable equilibrium. Any deviation from an equilibrium outcome will trigger beliefs that the currency issuer will be inflating in the future. This will happen regardless of the elasticity of substitution or other firms reactions. Competition will play no role in this mechanism.

In any sustainable equilibrium, the currency issuers will make positive profits[11] We considered that the number of firms was exogenous, so this is not a problem in our set up. However if we were to assume that there are many potential entrant firms ready to replace the incumbant firms, how would this be consistent with equilibrium? There are equilibria with positive profits, because we can build beliefs such that those firms would not be interested in entering. The beliefs would be that those firms would be maximizing short term profits, providing bad quality money, for any possible history.

Fixed costs can impose constraints on the set of equilibria, in our set up, or in alternative setups where the number of firms is endogenous. In our set up, for values of the entry cost close to zero, nothing relevant changes. Proposition 2 would still apply. However, if entry costs were high enough, the lower bound on stationary inflation would be higher than zero.

5 Conclusions

In this paper, we address an old question in monetary theory – can currency be efficiently provided by competitive markets? We first show a flaw in the standard "Bertrand competition" argument when suppliers compete on promises rather than on tangible deliveries. The key issue is whether promises can be 'automatically trusted', and expectations based on them always fulfilled. In the provision of currencies promised returns fulfill consumers' expectations when currency suppliers are fully committed to their promises. In this context, trust is automatically achieved and the competition mechanism results in an efficient allocation, provided suppliers do not have monopoly power.

However, expectations based on promises may not be automatically fulfilled, because suppliers may not be able to commit to future actions, i.e. the policy of maintaining future prices to achieve the promised returns. In

[11] Provided that $d(i)_t \leq 0$.

this context, it must be in the interest of suppliers to be trustworthy: future rewards must compensate the temptation to renege on their promises. The need for such future rewards determines a lower bound on the degree of efficiency that can be achieved in these markets. In the market for the provision of money, the lower bound requires non-negative inflation and, therefore, positive nominal interest rates, away from the Friedman's rule of zero nominal interest rates. A first corollary of this result is that Hayek's conjecture, that efficient monetary equilibria can be achieved through currency competition is not verified if currency suppliers make sequential decisions.

There is a second, somewhat disturbing, corollary to the previous result. Once the "trust mechanism" works it fully determines which equilibrium is achieved and, since beliefs sustaining trust are fairly arbitrary, there is an indeterminacy of such equilibria. That is, any positive inflation can be part of a stationary equilibrium outcome. In other words, the competition mechanism plays no role.

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