What do we know about Currency Competition?

By Martin F. Hellwig*

The paper presents a critical analysis of the proposals of Hayek and Vaubel for unregulated competition among private money suppliers. Because of externalities, time inconsistencies and moral hazard, these proposals are detrimental for outside money and, at best, dubious for inside money.

I am skeptical about the price theoretical foundations of Vaubel's[1] policy recommendations. This skepticism extends to the work of *von Hayek* (1976, 1977), which initiated our current concern with the optimal monetary constitution. Specifically, I have the following problems with the Hayek-Vaubel analysis.

A. Both, Hayek and Vaubel, neglect the distinction between inside and outside money. Their discussion of competition among outside monies is based on an invalid premise.

B. There are Pareto-relevant externalities in money demand decisions which justify the use of lumpsum taxation to create a real return on money.

C. In contrast to the market for an inside money, the market for an outside money is destroyed by the coexistence of more than one firm in the market.

D. Vaubel and Hayek fail to distinguish between the dynamic problem of time inconsistency and the static problem of monopoly power. In the absence of binding money supply announcements, the time inconsistency of profit maximizing policies rules out *any* unregulated private organization of the market for outside money.

E. The analysis of competing inside monies pays too little attention to the problems of uncertainty, information asymmetries, and time inconsistency that are endemic to debtor-creditor relations.

In the following, I shall discuss these points one by one.

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[1] Vaubel's analysis of external effects in the money market is presented in *Vaubel* (1984). My comments here cover that analysis as well because at the May 1984 meeting, it was presented as an integral part of the argument.

1. Inside versus Outside Money

We must distinguish between *inside money,* which gives its bearer a legal claim against the issuer, and *outside money,* which entails no such claim. Suppliers of inside money are constrained by the need to fulfill their obligations or else go bankrupt. Suppliers of outside money are under no such constraint. Presumably then, the behaviour of a money supplier will depend on whether he issues inside or outside money.[2]

The distinction between inside and outside money will also affect the demand for money. My willingness to hold paper outside money depends only on the prospect of selling this paper outside money to somebody else, who in turn is willing to pay a positive price only because he hopes to resell it to a third agent, who ... In contrast, the decision to pay a positive price for inside money is at least partly motivated by the prospect of calling the claim on the issuer. The shopkeeper accepts my check — not because he expects to resell it to his wholesaler, but because he will present it to my bank. Whereas the real value of outside money is *exclusively* determined by resale considerations, i.e. by expectations of its real value in future transactions, the real value of inside money will depend on the "fundamentals" of the underlying claim against the issuer.

Any positive or normative analysis of the monetary constitution must take account of this difference. Hayek and Vaubel neglect it, apparently because they believe that the existence of outside money itself is merely a consequence of government interference with the monetary system. According to this view, unregulated currency competition would lead to the disappearance of outside money and its replacement by inside money as a superior asset.[3]

However, as far as I can see, this point remains to be proved. Moreover, it is not clear that such an outcome is in fact desirable. For the economy as a whole, the use of paper money may be advantageous because it economizes on the holding of real assets. In a pure inside money economy, this advantage is partly lost because the supplier of money must hold a reserve against the claims on him. In the absence of outside money, this reserve will consist of real assets such as gold,

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[2] In stressing this distinction, I do *not* take issue with *Johnson's* (1969) proposition that "the real theoretical difference to be drawn is between interest-bearing and noninterest-bearing money". Johnson was concerned with the determination of the economy's net wealth rather than the behaviour of money suppliers. Even in the context of his analysis, the distinction between inside and outside money is apparent in the inside money suppliers' need to hold reserves against withdrawels.

[3] This proposition was explicity asserted by Vaubel in the oral discussion following the presentation of his paper and my comments.

machines, shares, etc. Quite possibly then, the pure inside money economy may be inefficient because it involves an *over*accumulation of real assets.

To make this point precise, consider the precautionary money holding model of *Bewley* (1980, 1982) and *myself* (1980, 1982). In this model, agents with uncertain commodity endowments save and hold assets for self-insurance against future endowment fluctuations. These agents' portfolio choices between money and commodity inventories depend on their expectations about real rates of return. Agents will be indifferent between money and inventories if both assets have a zero own rate of return and if prices are nonrandom and constant over time. A monetary rational expectations equilibrium with nonrandom, constant prices does in fact exist if the endowment risks of different individuals cancel out so that all economic aggregates are nonrandom.

In this equilibrium, the use of paper money as a store of value enables the system to economize on commodity inventories. This substitution of money for inventories is useful because commodity inventories require a deferral of consumption and thereby involve a real cost.

Up to this point, the argument does not depend on whether we are dealing with an outside money which happens to have a nonrandom, constant purchasing power or an inside money whose purchasing power is supported by an instant repurchase promise of the issuer. In the absence of aggregate fluctuations, the inside money issuer need not hold any inventories because in each period, the public's demand for his money just balances the available supply.[4]

However, if money does not bear interest, the private incentives for holding money are too small for Pareto optimality.[5] In the present context, the use of non-interest-bearing money as a buffer stock does not yield perfect insurance of individual risks even though such perfect insurance would be feasible. If we are dealing with a government supplied outside money, then the allocation can be improved by using the government's power to tax in order to create a positive real return on money.[6] This device is not available for a privately supplied inside

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[4] The substitution of a money without backing for a money with backing is perhaps best illustrated in the story, told by Peter Kenen, of the island which used sardine cans for money. A tourist once opened a can, found the sardines inedible, and complained to the person who had given him the can. The answer was: "There is nothing to complain about. I gave you money sardines. If you wanted food sardines, you should have gone to the supermarket!"

[5] *Friedman* (1969), *Johnson* (1969), (1970).

[6] *Hellwig* (1982).

money. Such a non-interest-bearing inside money would in fact be displaced by any government supplied outside money which has a positive real return.[7]

Furthermore, even without interest payments on money, the equivalence of inside and outside money disappears if the underlying uncertainty involves collective as well as individual risks. In this case, the real quantity of money that the economy wants to hold will fluctuate with the collective endowment realization. Therefore, the supplier of an inside money must expect that with positive probability the claims on him will be called. If the inside money represents a claim to real commodities, he must be prepared to actually deliver these commodities. If he wants to be sure to avoid bankruptcy — i.e. a default on his promise — then he typically needs to hold a 100 % reserve against his money issue.[8] In equilibrium then, inside money will have the same return structure as the underlying real asset to which it is a claim. Whether such an inside money can coexist with a non-interest-bearing outside money depends on (i) the extent of collective risk and (ii) the own rate of return and the carrying cost of inventories. The non-interest-bearing outside money is displaced by inventories or an inside money backed by inventories if the own rate of return on inventories is zero; it is not so displaced if inventories have a high carrying cost so that their own rate of return is close to $-100\,\%$.[9] Even in those instances in which a non-interest-bearing outside money is displaced by an inside money with a value guarantee or repurchase clause, this result is socially undesirable. In this case, the portfolio choice between outside money and inventory-backed inside money is biased against the former despite the potential allocational role of paper outside money as a socially costless buffer stock against individual, i.e. insurable endowment risks. As in the case of purely individual risks, welfare would be increased by the introduction of a tax-financed real return on outside money.

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[7] The argument in the text is based on the assumption that commodity inventories with a zero own rate of return are the only asset in the model. If we introduce real capital with a neoclassical production function, the argument must be modified along the following lines (due to Truman Bewley in private correspondence): *Any* non-interest-bearing money is displaced by real capital or by an inside money which promises the same real return as real capital and is backed by real capital. However, because of the precautionary demand for saving, there would be an *overaccumulation* of capital to a point where the net marginal product of capital is less than the rate of time preference in consumption. Again, welfare can be increased by the introduction of an interest-bearing outside money which is backed by the government's power to tax.

[8] The problem of default by an issuer of inside money, which is neglected by Hayek and Vaubel will be taken up in Section 6 below.

[9] *Hellwig* (1980).

In summary, if we are interested in the impact of competition on the monetary system, we must consider both, outside and inside monies, and we must be careful to draw the distinction between them.

2. Competition among Outside Monies

Both *Hayek* (1976) and *Vaubel* address the problem of competition among outside monies when they consider "the case for free currency competition among central banks". They claim that such competition "encourages less inflationary monetary policies" because the currency with the lowest inflation rate will be the most attractive to a public that is free to choose among the different currencies.

This claim rests on the implicit assumption that each issuing bank can at least partially control the inflation rate of its own currency through its supply behaviour. This premise is invalid.

To illustrate the basic problem, I consider an example of competition among two "currencies" that is taken from the recent past. The first

Table 1

	Annual Growth Rates over Preceding Year		Relative Price
	"Currency 1"	"Currency 2"	
1970	6,6	0,6	2
1971	9,5	1,8	2
1972	13,6	6,9	2
1973	5,3	— 1,2	2
1974	9,1	2,0	2
1975	9,1	3,5	2
1976	6,2	2,7	2
1977	12,0	6,0	2
1978	11,7	7,2	2
1979	5,0	2,0	2
1980	5,0	2,3	2
1981	0,1	— 0,7	2
Cumulative Growth 1970 - 1981	128 %	38 %	

Source: Statistisches Jahrbuch für die Bundesrepublik Deutschland.

two columns of Table 1 show the evolution of the outstanding quantities of the two "currencies". Over the period 1970 to 1981, "currency 1" grew by more than three times as much as "currency 2". Yet the last column shows that the relative price of the two "currencies" did not change. In each period, two units of "currency 2" were treated as a perfect substitute for one unit of "currency 1". In accordance with the Hicks-Leontief aggregation theorem, both "currencies" were in fact treated as parts of a single composite currency: Inflation concerned this composite currency as a whole rather than its individual components. The above average growth rate of "currency 1" probably raised the inflation rate of the composite currency and hence the common inflation rates of *all* individual components; it did *not* induce an above average inflation for "currency 1".

In this example, "currency 1" are blue pieces of paper on which the Bundesbank has printed the number "100"; "currency 2" are brown pieces of paper on which the Bundesbank has printed the number "50". We must now see to what extent the analysis of this example can also be applied to outside monies that are issued by different agencies which compete with each other.

First we need to note that the relative price of two DM 50,— bills for one DM 100,— bill is in fact a market price. One might object that DM 100,— is twice DM 50,— merely as a matter of arithmetic. However, here we are not concerned with arithmetic but with the price at which blue and brown pieces of paper, i.e. different physical objects, are exchanged in actual transactions. If you need to make an emergency phone call from a public phone booth at night, you may find yourself willing to part with a DM 10,— bill for much less than the ten DM 1,— coins that would be indicated by arithmetic.[10] Similarly, the scarcity of Italian 5 and 10 lire pieces is due to the fact that the central bank's arithmetic stands in no relation to the value of the nickel contained in these coins.

Once the relative price of DM 100,— and DM 50,— bills is seen as a market price, we must ask why the market seems to conform so well to the Bundesbank's arithmetic. The Bundesbank's readiness to intervene in support of the exchange rate of two DM 50,— bills for one DM 100,— bill provides only part of the explanation for this phenomenon. After all, there was a time when the Bundesbank also stood ready to support an exchange rate of DM 4,— for 1,— US $. It was significantly less suc-

[10] At the time of the opening of the then ultramodern Dallas-Fort Worth airport, the airport administration tried to cash in on this observation by installing money-change machines that returned 90 c in coins for a 1 $ bill. After considerable public protest, they had to abandon the idea.

cessfull then. Moreover, we observe that the Bundesbank hardly even needs to intervene in the market of DM 50,— for DM 100,— bills. What would happen, if it did not intervene at all? I submit that even in the absence of current or expected future interventions by the Bundesbank, the market might clear at the constant relative price of two DM 50,— bills for one DM 100,— bill. For consider any agent who expects two paper outside monies to have a relative price x in all future transactions. This agent will regard x units of one currency as a prefect substitute for one unit of the other currency. If the *current* relative price of the two currencies is also x, he will be indifferent between them; if the current relative price differs from x, the agent will have a strict preference for one of the two currencies. If the expected price x is the same for all agents, the current *equilibrium* price must also be x since otherwise no agent would be willing to hold the currency that is too expensive. If at all times all agents expect two DM 50,— bills to exchange for one DM 100,— bill in all future transactions, then two DM 50,— bills will exchange for one DM 100,— bill in all *actual* transactions even if the Bundesbank does not intervene at all. Thus the fixed exchange rate of two DM 50,— bills for one DM 100,— bill will correspond to a *rational expectations equilibrium.*

However, the same argument shows that if there is no Bundesbank intervention, then any other fixed exchange rate beween DM 50,— and DM 100,— bills will also correspond to a rational expectations equilibrium. More generally, *any economy with multiple fiat monies whose use in different transactions is not subject to exogenous constraints will have multiple rational expectations equilibria* (provided it has any rational expectations equilibrium at all). For any vector of exchange rates $x \geqq 0$, *such an economy will have an equilibrium in which all transactions take place at the fixed exchange rates* x.[11]

This analysis is directly applicable to the Hayek-Vaubel discussion of currency competition among central banks. At present of course, a dollar bill and a DM coin cannot be used side by side in all transactions. However, the Hayek-Vaubel proposal aims precisely at lifting those restrictions which limit the use of dollars in Germany and of marks in the United States. If this proposal is realized, then the two currencies will circulate side by side and their relative acceptability in an individual transaction will depend *only* on the participants' expectations about their relative resale value in future transactions. In such a world, *there can be no systematic differences in inflation rates between outside monies*: Any anticipation that the mark will be relatively worthless in the future must make it relatively worthless today already.

[11] Formal analyses of this principle are presented by *Girton / Roper* (1981), *Hellwig* (1976), *Kareken* and *Wallace* (1981).

3. External Effects in Money Demand[12]

I now consider the question whether money gives rise to Pareto-relevant external effects. It will be convenient to distinguish between the external effects in money demand and the external effects in the decision to use money rather than barter.

First, I must take issue with both *Friedman's* (1969) formulation and Vaubel's criticism of the price-level externality of money demand. Both authors use the language and the tools of *static equilibrium theory* for what is essentially a *non-static, sequential problem*. Unlike a refrigerator, money is not an asset that one buys once in order to hold it forever and to enjoy the "liquidity services" that it yields. Instead, money is traded back and forth: one acquires it, then resells it, acquires it again, etc. "Liquidity services" do not arise from the possession of money as such, but from the ease with which money can be resold. If one expects that with probability one, one will never actually use this resale opportunity, then one has no reason to hold money in the first place. The use of money must therefore be analysed in a framework of *sequential, incomplete markets* rather than the usual set of simultaneous, complete markets. In the sequential framework, the different periods and occasions in which agents trade money must be tied together by the concept of a rational expectations equilibrium, i.e. an *"equilibrium of plans, prices, and price expectations"*.[13]

In such a non-static setting, there is no presumption that pecuniary externalities are Pareto-irrelevant.[14, 15] For consider the effects of an increase in some individual's demand for money in period t. From the perspective of period t, this demand increase raises the value of money in that period, thereby conferring a positive pecuniary externality on all net sellers and a negative pecuniary externality on all net buyers of money in money in period t. Ceteris paribus, Vaubel is right in observing — against the formulation of *Friedman* (1969) — that these pecuniary externalities are Pareto-irrelevant.

However, from the perspective of period $t-1$, the increase in the (real) value of (nominal) money in period t serves to raise the indirect expected utility associated with money holdings at the end of period $t-1$. In terms of the temporary equilibrium of period $t-1$, this effect is a non-pecuniary externality and is definitely Pareto-relevant. It tends to raise the equilibrium value of money in period $t-1$, which in

[12] See Footnote 1.
[13] *Radner* (1972).
[14] See, e. g., *Scitovsky* (1954), 184 f.
[15] Contrary to footnote 14 in *Vaubel* (1984), a main point of Scitovsky's classic paper is the *Pareto-relevance* of pecuniary externalities outside the narrow framework of static equilibrium theory.

turn has further repercussions for period $t - 2$, etc. In a rational expectations model, an increase in the demand for money in some period thus has Pareto-relevant positive externalities in all prior periods. Because of the externalities, a permanent increase in the demand for money, i.e. an increase in all periods that is generated, e.g., by the creation of a real return on money can improve the allocation of resources.[16]

For a specific example, I again refer to the precautionary money holding models that were discussed in Section 1. In these models, agents with positive time preference are willing to accumulate money to the point where the marginal self-insurance benefit of additional money holdings just compensates for the difference between time preference and the return on money, i.e. the net opportunity cost of deferring consumption to hold money. If the net real rate of return on money is zero, agents' long run equilibrium real money holdings are finite and provide less than perfect insurance of individual endowment risks. The creation of a real return on money raises the real demand for money and hence the equilibrium value of money in all periods. In real terms, each individual then has larger buffer stocks, which provide better insurance against his endowment risks. Through the externality described above, the creation of a real return on money improves the allocation of resources by ensuring a better exploitation of the available insurance opportunities.[17]

Contrary to Vaubel's claims then, the demand for outside paper money involves a Pareto-relevant externality which justifies the creation of a real return that is financed from lump sum taxation. In general

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[16] This is of course *Friedman*'s main point. In terms of his (1969) formulation of money as an asset that yields "liquidity services" as it is held, the non-pecuniary externality arises because the liquidity services of money depend on its purchasing power. Money may then be compared to a refrigerator whose refrigerating power depends on its market price. A permanent increase in the demand for such an asset raises its price and, by a technological (!) external effect, changes the services per unit that it yields.

[17] *Vaubel* (1984) himself seems to accept this possibility when in footnote 17, he mentions "the condition that the (private?) opportunity cost of holding (real?) money should equal the (social?) opportunity cost of producing (real?) money" (my insertions) as the rationale for "creating a return on cash balances". However, he is mistaken when he claims that this rationale is not based on an externality and that "no subsidy is involved". The mistake arises from a confusion between the rate of time preference in consumption and the market rate of return on assets other than money. In the precautionary money holding model without real capital, the rate of return on inventories as the alternative asset is zero. With positive time preference, the condition that the opportunity cost of holding money be zero (the cost of producing real money balances) requires that money be subsidized and that the rate of return on money be *larger* than the return on inventories. In the model with real capital, money must again be subsidized to bring the common rate of return on money and real capital up to the rate of time preference (see fn. 7).

this measure requires a government intervention though not necessarily a government control of the money supply.

Vaubel himself concentrates his analysis of external effects on the choice between money and barter. The externality here is the same as the one in telephone networks: The more people own a telephone, the more people I can call, and the more attractive it is for myself to own a telephone. Similarly, the more people accept money as a medium of exchange, the more willing am I myself to accept it.[18]

However, if we talk about currency *competition*, it makes more sense to analyse this externality in terms of choices between different currencies and between different transactions networks rather than between money and barter. If there is, say, a postal giro system and a bank giro system, then my joining one or the other enhances the attractiveness of the one I choose for other agents. If there are costs to switching from one system to the other, it may be advisable to have a single transactions network rather than several networks that compete with each other. Once we consider the choice between different currencies and transactions networks, we can no longer accept Vaubel's conclusion that "where ... all economic agents use money, the transaction cost externalities of using money cannot be Pareto-relevant" (1984, 41).

4. The Supply of Outside Paper Money under Binding Precommitments

I now consider the behaviour of private suppliers of outside money. From the preceding discussion, it is clear that the analysis cannot be limited to a single period. The seigniorage that suppliers of money receive in the initial period depends on the market's expectation of the value of money in later periods, which in turn depends on the money supply in subsequent periods. In this section, I assume that *before the first period, each supplier of money makes a binding announcement of what quantities of his money he will supply to the market in periods* $t = 0, 1, 2, \ldots$ Given these announcements, the market finds a rational expectations equilibrium which determines the revenues of the different money suppliers.

4.1 Private Monopoly

Suppose first that outside money is supplied by a private monopoly. The monopolist chooses a sequence M_t, $t = 0, 1, 2, \ldots$ of money supplies. This sequence determines a sequence of real values of money π_t, $t =$

[18] It is, however, unclear whether this effect is at all different from the externality generated by (my anticipation of) somebody else's future demand for money as discussed in the first part of this section.

0, 1, 2, ... in the corresponding rational expectations equilibrium. The monopolist's revenues in periods $t = 0, 1, 2, \ldots$ are then given as $\pi_t (M_t - M_{t-1})$.

Under standard assumptions about the absence of money illusion in the economy, the sequence $\{\pi_t\}$ is homogeneous of degree minus one, and the sequence $\{\pi_t (M_t - M_{t-1})\}$ is homogeneous of degree zero in the sequence $\{M_t\}$. Thus a proportional change in the money supply sequence has no effect on the sequence of real revenues $\{\pi_t (M_t - M_{t-1})\}$.

If the marginal cost of producing paper money were positive, the monopolist's problem would have no solution. Clearly, $M_t = 0$ for all t cannot be a solution because this sequence yields zero revenues. On the other hand, any nonzero sequence $\{M_t\}$ would be dominated by the sequence $\{\frac{1}{2} M_t\}$, which for each t yields the same revenue at a lower production cost.[19]

The monopolist's problem typically does have a solution if the marginal cost of producing paper money is zero. In this case the monopolist is indifferent between all sequences $\{M_t\}$ that differ only by a constant of proportionality. He will only be concerned about the sequence of money growth rates $\mu_t = (M_t - M_{t-1})/M_{t-1}$ which is to be applied to an (arbitrary) initial money supply M_0. Under standard assumptions, an optimal sequence of money growth rates will exist.

The qualitative properties, in particular the welfare properties of the monopoly solution are unknown. In general, the solution will very much depend on the real structure of the economy, in particular on the alternative assets that are available.

As an example, consider again the precautionary money holding model. For any money supply policy in this model, the equilibrium real rate of return on money in any period cannot be less than the own rate of return on commodity inventories. Hence the rate of price inflation $\left(\frac{1}{\pi_{t+1}} - \frac{1}{\pi_t}\right) \Big/ \frac{1}{\pi_t}$ is bounded by the rate of inventory depreciation. If inventories do not depreciate at all, i.e. if the net own rate of return on inventories is zero, then there can be no price inflation, i.e. the value of money π_t cannot fall over time.

Given that the equilibrium rate of return on money is no less than the rate of return on inventories, we may suppose that in any period t, the economy's savings are all invested in money.[20] Hence the real value

[19] Technically, the problem arises from the discontinuity in the product $\pi_t M_t$ as $M_t \to 0$ and $\pi_t \to \infty$.

[20] If the rate of return on money is strictly greater than that on inventories, no inventories are held. If the two rates are equal, both the monopolist and the rest of the economy are indifferent between them. Hence

of money $\pi_t M_t$ in period t is just equal to the economy's real precautionary savings S_t. The monopolist's real revenues $\pi_t (M_t - M_{t-1})$ are equal to S_0 in period 0 and to $\frac{\mu_t}{1+\mu_t} S_t$ in periods $t = 1, 2, \ldots$ Depending on his own intertemporal tradeoffs, he cooses the money growth rates $\mu_1, \mu_2, \ldots$ to maximize some function of S_0 and $\frac{\mu_t}{1+\mu_t} S_t$, $t = 1, 2, \ldots$, taking account of the dependence of S_t on all future inflation rates and of the constraint that the inflation rate must never exceed the bound given by the rate of inventory depreciation.[21]

If the rate of inventory depreciation is zero so that there can be no price inflation, the monopolist simply chooses the largest money growth rates that are compatible with constant prices. For many specifications of savings behaviours, this involves setting $\mu_t = 0$ for all t. Typically, the optimal policy for the monopolist involves an exchange of the money's real assets S_0 against money in period 0 followed by zero money growth in all subsequent periods. It turns out that in the absence of taxes and subsidies that could finance the payment of interest on money, this policy actually is the "second best" welfare maximizing policy.

However, if the rate of inventory depreciation is positive, the monopolist will typically *not* hold the money supply constant. A sufficiently small growth of the money supply is now compatible with the bound on the rate of price inflation. This growth yields the seigniorage $\frac{\mu_t}{1+\mu_t} S_t$ in period t at the expense of adverse effects on savings and hence on the revenues S_0 in period 0 and $\frac{\mu_\tau}{1+\mu_\tau} S_\tau$ in periods $\tau = 1, 2, \ldots, t-1$. Unless the adverse effects on S_0 and $\frac{\mu_\tau}{1+\mu_\tau} S_\tau$ for $\tau = 1, \ldots, t-1$ are very strong, the monopolist will choose $\mu_t > 0$ in period t to enjoy the seigniorage income from further money growth. In this case, the policy chosen by the monopolist will *not* coincide with the "second best" welfare maximizing policy of zero money growth.

In summary, the behaviour of an unregulated private monopoly in the supply of outside money is extremely sensitive to the specification of the model. There is, however, no presumption that the policy chosen by

there is no loss of generality in assuming that in each period the monopolist issues enough money so that the rest of the economy holds no inventories. If the monopolist is impatient, he will actually have a preference for this.

[21] From the equation $\pi_t M_t = S_t$, this constraint may be written as

$$\mu_t + (1+\mu_t)\frac{S_{t-1} - S_t}{S_t} \leqq \frac{\delta}{1-\delta},$$

where δ is the rate of depreciation on inventories. For $\delta = 0$, this constraint requires $\mu_t \leqq 0$ unless savings are increasing over time.

such a monopoly will be in any sense desirable. On the contrary, one must expect that *the monopolist's desire for seigniorage income induces him to have "too much" inflation from a welfare point of view.*

4.2 Actual Competition

As an alternative to monopoly, consider a world with many outside money suppliers. Each outside money supplier f chooses a sequence of money supplies m_t^f for $t = 0, 1, 2, \ldots$ In view of the discussion of Section 2, I assume that the market implements a rational expectations equilibrium for which there exists a vector $x \geqq 0$ such that in all periods, the monies supplied by suppliers f and f' exchange at the relative price $x_f/x_{f'}$. By the Hicks-Leontief aggregation theorem, outside money then may be regarded as a single composite commodity with the aggregate quantity $M_t = \sum_f x_f m_t^f$ for $t = 0, 1, 2 \ldots$ If π_t again is an index of the real value of this aggregate in period t, then supplier f's revenues in period t are equal to $\pi_t x_f (m_t^f - m_{t-1}^f)$.

Suppose first that every supplier f takes the prices $\pi_t x_f$, $t = 0, 1, 2, \ldots$, of his money as given. If production costs are zero and if $\pi_t x_f > 0$, then his profit "maximizing" flow money supply $(m_t^f - m_{t-1}^f)$ is infinite. Since the economy's real resources are finite, this cannot be an equilibrium. In equilibrium, it must be the case that $\pi_t x_f = 0$ for all t and all price-taking money suppliers f. Then the equilibrium real value of the aggregate quantity of money $\pi_t M_t = \sum_f \pi_t x_f m_t^f$ is equal to zero for all t. *Far from remedying the evils of monopoly, the introduction of competition with many price-taking money suppliers merely destroys the use of outside money altogether.*

This conclusion is well known.[22] Vaubel's assertion to the contrary is again due to his failure to distinguish between inside and outside money.[23] An inside money supplier looks not only at the price $\pi_t x_f$ at which he can sell his money, but also at the cost of fulfilling whatever promise he makes to his clients. If this cost is too large, he will not be in the market at all even though $\pi_t x_f$ may be positive. Inside money suppliers therefore compete on the relation between the content of the promise they make and the price $\pi_t x_f$ that they get. As Vaubel correctly notes, this type of competition drives the market's opportunity cost of holding money to zero, but the price of inside money remains positive. However, this conclusion breaks down for outside money which does not involve any claim of the holder on the issuer. For this case, the

[22] See, e. g., *Pesek / Saving* (1967), 69 ff.
[23] See *Vaubel* (1985) 3, 9.

analysis above shows that competition among price-taking money suppliers cannot work.[24]

The preceding conclusion even holds for the case of a finite number of (non-price-taking) Cournot oligopolists. If there is no money illusion in the economy, the real quantity of money $\pi_t M_t$ in period t is equal to a real variable S_t, which depends on rates of return and relative prices, but *not* on the nominal quantity of money. A Cournot oligopolist will thus evaluate his revenues in period t as $S_t x_f (m_t^f - m_{t-1}^f)/M_t = S_t x_f (m_t^f - m_{t-1}^f) / \sum_{f'} x_{f'} m_t^{f'}$. No matter what the constellation of supply policies is, he finds that he can always increase his revenues by raising m_t^f and hence his share in the aggregate money supply M_t. In the absence of production costs, the oligopolist's profit "maximizing" supply of outside money is again infinite. *Hence Cournot oligopoly also destroys the use of outside money.*

These results suggest that the *supply of outside money should be regarded as a natural monopoly* not in the technical sense of a subadditive cost function, but in the looser sense that any other organization of the market will destroy the market itself.

4.3 Potential Competition

Even if one accepts the conclusion that outside money should be supplied by a single firm, it is not clear that one must put up with an unregulated monopoly. The preceding analysis shows that *actual* competition among several firms will not work. However, the recent work of *Baumol, Panzar* and *Willig* (1982) on contestable markets shows that quite often the threat of *potential* competition is enough to discipline an otherwise unregulated monopolist.

Drawing on these authors' ideas, we may consider the following scheme. Consider a regulation whereby the supply of outside money is subject to a franchise. If no more than one money supplier is enfranchized, this regulation will prohibit the actual coexistence of different firms in the market.

However, competition may now be introduced by having different potential money suppliers bid for the franchise. Their bids must specify both a sequence of money supplies $\{M_t\}$ that they are going to implement and a sequence of seigniorage taxes $\{T_t\}$ that they are willing to pay in order to get the franchise.

[24] *Vaubel* (1985, p. 3) draws attention to the confusion between the price of money and the opportunity cost of holding money in the work of *Pesek / Saving* (1967). Their work was flawed because they indiscriminately applied to an inside money economy the conclusions that they had first obtained for an outside money economy. The reverse procedure is also problematic.

The question is how the franchise is to be awarded. If there is no conflict about the ranking of any two bids $\{M_t^1, T_t^1\}$ and $\{M_t^2, T_t^2\}$, then the regulatory commission should simply award the franchise to the bidder whose bid is (unanimously) ranked highest. The bidders are thus involved in a type of Bertrand game in which they make "contract" offers and "the public" chooses whichever contract maximizes its utility. The usual Bertrand argument shows that in an equilibrium of this game, the winning bid must be the one that is most highly ranked among *all* those that are technically feasible and do not impose a net loss on the bidder.

In contrast to the unregulated monopoly, the approach would *always* lead to the second best monetary policy, i.e. the one that is best among all policies that do not rely on the government's power to tax. Moreover, in this approach even the seigniorage would not stay with the winning bidder but would be channelled back to the economy through the seigniorage taxes T_t.

The preceding analysis has its weak spot in the assumption of unanimity among the users of money. In general, there is no reason to expect such unanimity. Different people with different tastes will have different views about monetary policies and the distribution of seigniorage. In this case, the criteria of the regulatory commission become problematic. However, the distributional conflicts that arise are no different than the distributional conflicts arising in any other area of collective choice, or, more narrowly, in any other regulatory problem. The problem of regulating the supply of outside money no longer is a problem *sui generis*, but it has been brought into the confines of traditional public choice and welfare analysis. Even if one is pessimistic about the possibility of resolving the distributional issues that arise, one may still expect that a commission of the sort that is suggested will pay rather more attention to the public's aversion to inflation and less attention to the money suppliers' desire for seigniorage than an entirely unregulated monopoly.

5. The Problem of Time Inconsistency

I now turn to what is probably the most important problem for any monetary constitution. Up to now, I assumed that the sequence of money supplies is announced before the first period and that this announcement cannot be revoked in any later period. In practice there is no reason why such initial announcements should be binding at later dates. The question then is how the money market behaves in the absence of binding announcements of future money supplies.

If initial announcements are not binding, the optimal policy precommitment $\{M_t\}$ of an unregulated private monopoly that was discussed in Section 4.1 no longer is an equilibrium. This conclusion is obvious in those cases in which the money supplies M_t are constant and $\mu_t = 0$ for all t. With zero money growth, the monopolist earns the revenue $\pi_0 M_0$ in period zero and nothing thereafter. From the perspective of period 0, this may be a good policy because zero money growth and zero inflation in later periods enhance the real revenue $\pi_0 M_0$ in period 0. From the perspective of period 1, the revenue $\pi_0 M_0$ of period 0 is forever bygone and does not enter into the monopolist's considerations any more. From the perspective of period 1 the zero money growth policy continuation with zero revenues in all periods $t = 1$ is dominated by a policy of positive money growth and positive revenues in some periods.

More generally, let $\{M_t\}$ be the optimal policy precommitment of the private monopolist, and recall that this policy yields the real revenues S_0 in period 0 and $\frac{\mu_t}{1+\mu_t} S_t$ in period $t \geqq 1$, where $\mu_t = (M_t - M_{t-1})/M_{t-1}$ is the money growth rate and $S_0, S_1, \ldots$ are the economy's *real* money demands in periods $0, 1, \ldots$ at the given rates of return. For a given quantity of money M_0 in period 0 and given money growth rates μ_t for $t \geqq 2$, the quantity of money M_1 in period 1 affects *only* the real money demand S_0 in period 0 and the seigniorage income $\frac{\mu_t}{1+\mu_t} S_1$ in period 1. The seigniorage income is an *increasing* function of μ_1 and hence, for given M_0, of M_1. Nevertheless, from the perspective of period zero, it is not desirable to set $\mu_1 = \infty$ because a large value of M_1 entails a low real value of money $\pi_1 = S_1/M_1$ at date 1, and under rational expectations, a low real value of money π_0 at date 0. (If inventories have no carrying costs, arbitrage between inventories and money ensures $\pi_0 = \pi_1$; if arbitrage considerations impose no bound on the rate of inflation, intertemporal substitution will reduce S_0.) However, from the perspective of period 1, this consideration plays no role, and the revenue "maximizing" policy requires an infinite money growth rate.

The basic rationale of the argument is very simple: At any date t, a fixed pattern of money growth rates $\mu_{t+1}, \mu_{t+2}, \ldots$ induces a certain pattern of expected inflation rates, which determines the real resources S_t that the economy is willing to spend on its money holdings at the end of period t. These real resources S_t are shared between the monopolist and the previous holders of money in proportions $\frac{\mu_t}{1+\mu_t}$ and $\frac{1}{1+\mu_t}$. By making μ_t indefinitely large, the monopolist can dispropriate the previous money holders and raise his portion of the quantity S_t that goes into money.

In general then, the monopolist's revenue-maximizing policy is *time-inconsistent*[25] because in later periods, the monopolist wants to deviate from this policy. It follows that the monopolist's initial announcement will not actually be *credible* unless he can devise an institution that makes this announcement binding.

Moreover, it is now easy to see that *in the absence of binding pre-commitments about future money supplies, there cannot be any equilibrium in which the value of money is positive.* The preceding arguments show that no matter what situation we are considering, as of period t, the monopolist has an incentive to make M_t and μ_t arbitrarily large (and hence π_t arbitrarily close to zero). Under rational expectations, this future behaviour of the monopolist is anticipated by the market. With this anticipation, the market sets $S_\tau = \pi_\tau = 0$ for $\tau < t$ because nobody wants to spend real resources on an asset that will be made worthless by the monopolist's future behaviour. In general $S_t = \pi_t = 0$ for all t is the only possible equilibrium.

In summary, an unregulated private monopoly without binding commitments destroys the use of outside paper money just as surely (and by almost the same argument) as the coexistence of several competing outside money supplies.[26] I conjecture that this conclusion does in fact hold for *any* unregulated private organization of a market for outside paper money.

I also believe that the problem of time inconsistency bedevils any government run or regulated monetary system. This is obvious if the government itself behaves like a revenue-maximizing monopolist. Most of *von Hayek's* (1977) historical overview illustrates the very conflict between the monetary stability that is promised to make money acceptable and the money growth that is generated later to raise revenues.

However, time inconsistency would probably be a problem even if the government were run by welfare economists who do not try to maximize seigniorage revenue *per se*. For consider again the model of Bertrand competition among potential money suppliers that was discussed in Section 4.3. Suppose that the regulatory commission has awarded the franchise to a firm with a bid $\{M_t, T_t\}_{t=0}^{\infty}$. In period 0,

[25] This time-inconsistency was first discussed by *Calvo* (1978). For the general problem of time-inconsistency of monopoly in a durable goods market, see *Coase* (1972) and *Stokey* (1981).

[26] See *Coase* (1972) on the analogy between the durable goods monopoly and perfect competition. Because of the peculiarity of money, the conclusion here is even stronger than Coase's, which holds only if the time span between subsequent market dates is small, see Stokey (1981).

the initial money supply M_0 and seigniorage tax T_0 are implemented. Now in period 1, the winning firm (or some other firm) presents a new bid $\{\hat{M}_t, \hat{T}_t\}_{t=0}^{\infty}$ to the regulatory commission, which it finds preferable because the net seigniorage revenues $\hat{\pi}_t(\hat{M}_t - \hat{T}_t)$ under the new policy are higher than the net seigniorage revenues $\pi_t(M_t - T_t)$ under the old policy. How will the regulatory commission react to this new bid?

At this point, there is going to be an important *distributional conflict* in the economy: Those who have held money from period 0 will object to any increase in the quantity of money M_1 because it reduces the value of their own money holdings; those who do not hold any money will *not* object unless the new proposal also raises the inflation rate from period 1 to period 2 and thereby worsens the intertemporal price ratio with which they are faced. The latter agents will actually favour the proposed policy change if they can share in the spoils by obtaining a large portion of the seigniorage tax $\hat{T}_1$.

The regulatory commission's reaction to the proposed change in monetary policy will therefore depend on the commission's composition and on its rules of procedure. Specifically the question is how the commission's rules of procedure adjudicate the distributional conflict between money-holders and non-money-holders.[27] The most conservative rule would require *unanimity* for any changes in policy and would thereby give either group an effective veto. A unanimity requirement would probably eliminate the problem of time inconsistency by making it impossible to change monetary policy.

On the other hand, a unanimity requirement will make it hard to agree on a winning bid in the first place. Moreover, it might be desirable to discipline the firm that has been awarded the money supply franchise by threatening to give the franchise to another bank if it fails to comply with the terms of the contract. If such a move requires an unanimous agreement by all members of the commission, then the threat is not very effective, and the existing supplier of outside money can try to violate the terms of the winning bid without much fear of repercussions.

However, for any voting rule that does not require unanimity of decisions about monetary policy, time inconsistency is likely to be a problem. I suspect that time inconsistency is indeed the deepest and least solvable problem for the monetary constitution.

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[27] In Section 4.3, this distributional conflict played no rule because prior to the determination of the winning bid there were not yet any money holders.

6. Competition among Inside Monies

To conclude the discussion, I briefly consider competition among inside monies, i.e. among monies whose issuers give their clients a claim of some sort or other. In the simplest case, the holder of an inside money has the right to obtain a certain specified quantity of a real good, an asset, or another money upon demand or at some prespecified date. The Hayek-Vaubel notion of a "value guarantee" is a bit more complicated because it does not seem to involve a *legal* claim of the money holder on the money issuer. Instead, the value guarantee is publicly announced as the guiding principle for future policy.[28] However, as long as the money issuer fulfils his obligation, it does not matter whether the obligation arises from a policy announcement or from a legal claim. The distinction matters only when the money issuer defaults on his promise and the question is how one can make him pay.

If we accept the usual treatment of demand deposits as "money", we see that most countries already have some competition among inside monies. However, this competition is rigidly regulated by the government. The Hayek-Vaubel proposal amounts to an outright abolition of all government regulation of this sector. In particular, they want to abolish the following regulations:

a) The ban on the issue of private bank notes that can circulate as money.

b) The requirement to hold (minimum) reserves in central bank money.

c) The requirement to denominate the private money issuer's obligation in units of central bank money.

I should wholeheartedly support these proposals if we lived in a world in which all agents are completely informed about everything and all contracts and promises are always honoured. Unfortunately, the very use of money has to do with the fact that we do not live in such a world. Given the imperfections and uncertainties of actual markets, I see no conclusive evidence either against or for government regulation of the banking system and the market for inside money. Economic theory simply has too little to say on these matters to warrant any firm conclusions of the sort Hayek and Vaubel want to draw.

The relation between the holder and the issuer of an inside money is akin to that between a creditor and a debtor. This relation is problematic because when the contract is made the creditor surrenders a real asset and gets no more than a piece of paper with a repayment promise for the future. The whole creditor-debtor relation hinges on

[28] *Hayek* (1977), 31.

the question what this promise is going to be worth. In considering this question one must deal with a whole spectrum of difficulties arising from uncertainty, moral hazard, asymmetric information, and again time inconsistency. These difficulties which beset the theory of credit markets are just as important in the market for inside monies.

6.1 Uncertainty and Product Heterogeneity

The returns that the bank earns on its own investments are typically uncertain. Therefore, its own ability to fulfil its obligations to the holders of its money is uncertain. The returns on inside money will generally be uncertain and will depend on the bank's own investment policy. In consequence the inside monies issued by different banks will be less than perfect substitutes for each other. Inside monies must be regarded as a set of differentiated products rather than a single homogeneous product. Competition among inside monies then must be analysed as monopolistic competition in the sense of Chamberlin rather than perfect competition. In a world of Chamberlinian monopolistic competition, there is no presumption that the market outcome has any nice welfare properties.[29]

Both Vaubel and Hayek are aware that the market for inside monies must be analysed in terms of differentiated rather than homogeneous products. They do not seem to be aware that the welfare properties of monopolistic competition in a differentiated products market are quite unclear.

6.2 Moral Hazard and Bankruptcy

The return that an inside money holder eventually gets depends on the behaviour of the issuer of the money. If the issuer selects poor investments, the holder of the inside money gets a poor return — like those depositors who suffered from Herstatt's bad currency speculations. If the issuer embezzles the company's funds, the holder of the inside money gets a poor return — like those IOS certificate holders who suffered from Mr. Vesco's depleting the fund's assets. In principle, the contract between the issuer and holder of an inside money might prescribe the most careful behaviour on the side of the bank; in practice, the holder has no way of enforcing such a clause.

The recent literature on credit rationing and credit contracts shows that many institutional peculiarities in capital markets may be interpreted as devices that eliminate or reduce such instances of moral

[29] See, e. g. *Hart* (1983).

hazard. Thus, the standard debt contract with a fixed repayment obligation and bankruptcy if and only if the repayment obligation cannot be met may be interpreted as the market's response to the moral hazard that arises if the debtor (here the bank), but not the creditor (here the money holder) can costlessly observe the realized return on the debtor's investment.[30] In the same setting, banks as intermediaries may serve to reduce the agency costs of financing final real investment.[31] Credit rationing with bounds on both loan sizes and interest rates may serve to induce less risky investment policies by debtors and banks.[32]

Such devices reduce, but do not eliminate the problem of moral hazard in financial relations. The central issue is that the behaviour of a debtor, in particular the issuer of an inside money, exerts an external effect on the creditor, in particular the holder of the inside money. Because of this external effect, market allocations will generally not be more than n-th best, and it is unclear whether government intervention is harmful or useful.

To some extent, *Vaubel* seems to see that moral hazard might be a problem. He suggests that the danger of "profit snatching" can be eliminated through value guarantees ((1985), 554).[33] However, he does not see that such guarantees themselves might be subject to moral hazard and therefore might not be credible. A value guarantee, debt obligation and the like may eliminate moral hazard if the penalties for non-compliance with one's obligation are very large. If as in the Vesco-IOS case, the penalties are small in comparison to the gains from noncompliance, then such obligations may simply be irrelevant.

Morever, even if the penalties are large enough to eliminate outright dishonesty, they may still not be large enough to ensure an appropriate investment policy ex ante.[34] Could it be the case that minimum reserve requirements for banks or investment regulations for insurance companies are just one admittedly coarse way to "internalize" the effects that these companies' decisions have on their financiers through the risk of bankruptcy?

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30 *Gale / Hellwig* (1983).

31 *Diamond* (1984).

32 *Jaffee / Russell* (1976), *Stiglitz / Weiss* (1981).

33 Vaubel himself dismisses the Klein-Tullock argument that moral hazard is less of a problem in a repeated-game setting in which banks care about their long run prospects. This argument requires that agents do not discount the future so that no matter how large the short turn gains from dishonest or negligent behaviour may be, they are always outweighed by the infinite tail of continued future relations with one's creditors. At least Mr. Vesco does seem to have had a positive discount rate.

34 See, e. g. *Stiglitz / Weiss* (1981).

6.3 Moral Hazard and Time Inconsistency

If a debtor tells his creditor that he cannot pay, does the creditor call a bankruptcy or does he wait in the hope of sharing in the debtor's better luck in the future? Given the moral hazard problems discussed above, it seems desirable *ab initio* to threaten bankruptcy fairly quickly in order to induce the debtor to take care to avoid bankruptcy. However, *after* it has been determined that the debtor cannot pay, at least at present, the creditor may prefer to keep him alive. If bankruptcy is called immediately, the creditor has to write off his claims on the debtor. If bankruptcy is not called, there might be a time in the future when these claims could be collected. The decision to call a bankruptcy is thus subject to time inconsistency just like the optimal supply of outside money.[35] Concrete examples of these considerations have been observed in recent proceedings concerning the City of New York as well as the so-called "International Debt Crisis".

In those cases where the debtor is a large bank and the debts are inside money held by the public, the reluctance to call a bankruptcy seems to be especially great. In the case of the Continental Illinois Bank, it was made clear that because of adverse effects on the monetary system, a large bank would not be allowed to go bankrupt no matter how many bad loans it might have made. The problem is, of course, that if the banks know this, then they have no reason to avoid making bad loans. More generally, debtors who know that they will not be put into bankruptcy have only weak incentives to manage their means carefully so as to make sure that they can fulfil their obligations.

In summary, I believe that the markets for inside monies and the larger set of capital markets of which they form part are so replete with market imperfections, information asymmetries and problems of moral hazard that we cannot make any firm assessment about the welfare properties of the outcomes in such markets. Whether government regulation in these markets is warranted at all, whether it should take the form it does take, is something that at present we do not know — unless of course we start from the axiom that everything would be for the best in the best of all possible worlds if only the government ceased interfering. If we do not accept this axiom, we must admit that we simply do not know very much about how competition among inside monies works.

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[35] *Hellwig* (1977).

Summary

The paper studies the proposals of Hayek and Vaubel for unregulated private competition in the money market. These proposals are shown to rest on an insufficient distinction between *inside* and *outside* money. The existence of an outside money without a backing is desirable on welfare grounds. However, *any* private supply of outside money in perfect competition, Cournot oligopoly or monopoly would actually destroy the use of outside money. The main problem is that of *time inconsistency* of the optimal money supply policy. Problems of time inconsistency and of moral hazard arise also in the market for inside money. Because of these problems, the appropriateness of unregulated competition in the market for inside money must also be doubted.

Zusammenfassung

Die Arbeit befaßt sich mit den Vorschlägen Hayeks und Vaubels zur Einführung des Wettbewerbs im Geldwesen. Es wird gezeigt, daß diese Vorschläge auf einer unzureichenden Unterscheidung zwischen *Außengeld* und *Innengeld* beruhen. Die Existenz eines Außengeldes ohne Deckung ist aus wohlfahrtstheoretischen Erwägungen wünschenswert. Ein privates Angebot an Außengeld im Wettbewerb, Cournot-Oligopol oder Monopol würde aber die Funktionsfähigkeit des Marktes für Außengeld zerstören. Zentrales Problem ist die *Zeitinkonsistenz* jeglicher Geldangebotspolitik. Zeitinkonsistenzprobleme in Verbindung mit „moral hazard" treten auch im Markt für Innengeld auf und lassen auch hier die Angemessenheit der Vorschläge von Hayek und Vaubel als zweifelhaft erscheinen.

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