MONOPOLISTIC COMPETITION AND THE THEORY OF PRIVATE MONEY

by

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INTRODUCTION

The received theory of private, competitive fiduciary money (Klein, 1974) adopts a traditional neoclassical view of the nature of production technology and market demand for 'money.' That is, competitive producers are assumed to face a perfectly elastic demand curve for their 'money' in the sense that perfectly substitutable monies are presumed to exist. In part, this view may derive from prior consideration of a uniform physical medium of exchange, such as the gold or silver systems, in which such production and demand assumptions appear to be reasonable approximations. These suggestions also allow the work to center on resolving questions of over-issue and price level determinacy.

In this paper, by contrast, the nature and efficiency of a private monetary equilibrium is analyzed under some non-neoclassical assumptions about production and demand. First, as in the literature surveyed by Lancaster (1979), producers are assumed to have declining marginal costs and to face a downward sloping demand for a particular 'specification' of a monetary commodity. Thus, the monetary industry has a monopolistic competition equilibrium. Second, it is assumed that the utility of a specific money to an individual demander depends negatively on the number of other monies.

These assumptions accord with some traditional critiques of private monetary systems. The assertion that there are economies of scale in some elements of note issue and banking is a very old one. For example, Jevons (1875) notices that "Instead of a great number of small, weak, disconnected banks, there is, arising by amalgamation and extinction of the weaker ones, a moderate number of important banks." More recently, Tobin (1980) has argued that the use of a "particular money by one individual increases its value to other actual or potential users," which corresponds to the sort of external economy discussed above. In the current framework, however, one can be more specific about the nature of the desirable public interventions into the monetary sector that derive from these assumptions about production and demand. In particular, it can be desirable for the government to restrict entry into the market for note issue and banking, which has occurred during many periods in the U.S. and elsewhere.

The organization of the remainder of the paper is as follows. In section 1, specific characteristics of the monetary sector are discussed that lead to the production and demand conditions highlighted above. These are illustrated (in the tradition of mondern monetary economics) with a parable about an island economy. In section 2, the formal structure of the model with its explicit consideration of producers and consumers, is introduced. The equilibrium of the system is developed section 3, while in section 4 the incentives and possibilities for government regulation are presented.

SECTION 1

Three factors distinguish the present model from other recent contributions to the private money literature, such as Klein (1974) and Taub (1985). These factors: decreasing costs, differentiated monies, and informational externalities, have underlain traditional concerns of previous students of the competitive money problem. To provide a concrete illustration of these factors this section concludes with an island parable in which the heterogeneity of products is represented by physical location, economies of scale are manifested as walking distance, and the monetary externality is represented as an exchange rate cost. Section 2 below lays out the more general model, which admits interpretations that more closely approximate the real world.

ECONOMIES OF SCALE

Both before and after Laughlin's (1915) polemics on the "Banking Octopus" economists and the general public have feared the concentration caused by economies of scale in the banking and note issuing sector, often justifying government involvement in the fiduciary sector on that basis alone. Though his formal model excludes such economies Klein (1974) insightfully portrays their consequences.

> Alternatively, the government may supply the dominant money because of natural monopoly characteristics of the industry. Given declining costs of supplying information, a single firm or private trade association would be efficient in producing confidence . . . . But other industries that are natural monopolies often lead to government franchises and public regulation instead of governmental monopoly production.

In particular, if a bank backs notes or deposits with specie (or scarce notes of a dominant bank) a stochastic demand for redemption may lead to a square root rule for the optimal reserve amount. Since forgone interest on reserves is a real cost, the square root nature of demand indicates economies of scale in circulation as larger banks hold a lesser fraction of assets as reserves. Specific commonly used models of banking imply such economies of scale (see Baltensperger (1980)).

For present purposes it is important to stress that economies of scale need not be the vast sort associated with public utilities. In the model developed in section 2 below, any non-increasing economies of scale are permissible. Some will be the sort that obtain with the formation of any business, such as a building, location, indivisibility of labor and equipment (computers, typewriters). Other economies are particularly important for money producers. In his study of banking in Scotland, White (1980) points out that

> there emerged substantial economies of scale in producing banknote services, i.e. the public confidence and other qualities necessary to keep banknotes in circulation in a competitive environment. But these economies were always limited. Thomas Kinnear, an Edinburgh private banker who also served as director of the Bank of Scotland testified (BSP1826a, p. 132) that the Bank of Scotland had been forced to abandon some of its branch offices due to competition from local banks.

Decreasing costs require an alteration in the equilibrium concept employed by Klein. With a finite number of firms, the strategic interactions are best handled by the theory of monopolistic competition. In part, this theory 'softens the blow' and avoids the extreme predictions of increasing returns (i.e. natural monopoly) by replacing the assumption of perfect substitutability between monies with preferences dependent on a money's particular 'specification.' The desire of different people for different types of money counteracts the effects of decreasing costs. The differentiated products framework itself allows determination of the number and specifications of private monies as well as raising issues of trading off economies of scale for greater variety in production. This analysis also explicates the non-price factors, that is, the attributes of circulating money, as an interesting, if secondary, result.

INFORMATION AND EXCHANGE COSTS

An ancient and common criticism of private money systems stresses the inconvenience of many currencies. Multiple monies increase the transaction and information costs associated with exchange. Determination of a particular money's value involves time and effort, as does detection of counterfeits. This reallocation would be visible in production and use of banknote reporters, shifts in patterns of exchange, etc. Mundell (1961) cogently argues that

> Any given money qua numeraire or unit of account fulfills this function less adequately if the prices of foreign goods are expressed in terms of foreign currency and must then be translated into domestic currency prices. Similarly, money in its role of medium of exchange is less useful if there are many currencies; although the costs of currency conversion are always present, they loom exceptionally large under inconvertibility or flexible exchange rates . . . . Money is a convenience and this restricts the optimum number of currencies.

The previously discussed conventional models of private monetary systems, which utilize constant returns to scale and classical forms of demand are deficient in that they leave the number of monies indeterminate, and thus preclude consideration of exchange costs based on the number of monies. Monopolistic competition theory uses scale economies to endogenously determine the number of circulating monies, enabling us to investigate the externality.

Conventional theories have also focussed on firms' incentives to over issue currency and impose a capital loss on holders of their money. The present model's cost is avoidance of such time inconsistency and reputational issues. More explicitly, consider money as a durable good. Coase (1972), Bulow (1982), Stokey (1981), King (1982) and others have shown the incentives for imposing a capital loss on the owners of the good; yet all realize that a contract system sufficiently evolved to allow pre-commitment, in effect of rental of durable goods (money) services, implies the incentives for depreciation (over issue) are no longer extant. The present work assumes such a technology. The decision problem becomes a single period rental question.

AN EXAMPLE

In order to illustrate the model's major features the remainder of this section presents a parable about an island economy involving decreasing costs, diverse preferences, and exchange and information costs related to the number of monies in circulation.

Consider a circular atoll in the Pacific Ocean, a ring of an island enclosing a lagoon. Because of climate differences each point on the island produces a slightly different non-durable fruit crop and a unique type of clam (just offshore in the lagoon). Each point is also occupied by a native who does not own a canoe. Since fruits differ between location incentives for trade exist, and in the absence of a double coincidence of wants, money will be useful. Banks provide the commodity money, clams, along with services such as counting and saving. Banking is subject to increasing returns to scale, so there is a finite number of banks and a finite number of clam species in circulation. In the tradition of Lucas, Townsend, and Stockman, imagine the following daily transactions sequence which will rationalize the model's money demand structure (see figure 1). Each day, an individual wakes and

1. harvests fruit
2. walks to the bank, trading along the way
3. at bank, re-adjusts money(clams) held, adjusts savings
4. walks home, again trading
5. consumes, sleeps.

Walking requires time and effort, involving a disutility and an

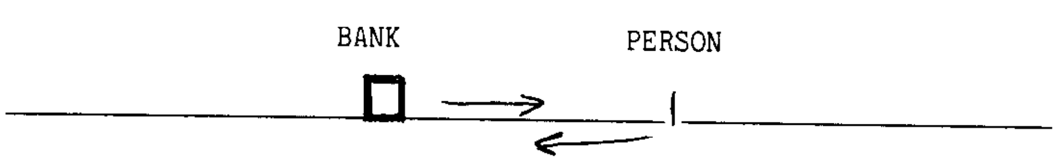

Figure 1: The Transactions Sequence

opportunity cost. The number of banks will be determined by the trade-off between the banks' decreasing costs and the toil and trouble of travel. Even if the lowest production cost for bank services meant having only one bank on the island, some individuals would find the walk so wearisome that they would gladly patronize a bank nearer home despite a higher service charge or lower fruit/clam exchange rate. This transactions sequence and the associated time costs imply agents utilize the nearest bank. Thus the island divides up into mutually distinct tribes. Each tribe uses a distinct species of clam.

This example emphasizes decreasing costs and preferences over money distinguished by characteristics. Some analogues of the distance aspect might be: the risk and return of assets backing the currency, the proportion of purchasing power and services provided, or the liquidity and interest of the money. Utility varies inversely with the difference between the money most preferred and the money provided by the 'closest' bank. As long as there are some economies of scale, a finite number of monies results from the trade-off between lower prices and more variety.

Now assume canoes are invented. Consequently natives can sail to the small sandy island in the center of the lagoon and engage in trade, taking the opportunity to consume exotic products from the other side of the atoll. The center island is too small for banks while tricky currents in the lagoon only allow trips to the center; no trips to other tribal areas are safe. Natives follow the new transactions sequence: (see figure 3).

1. harvest fruit
2. sail to bazaar island
3. trade
4. sail home
5. walk to bank

6. transact the bank

7. walk back

8. consume sleep.

Money is still useful on the trading island but each tribe will be

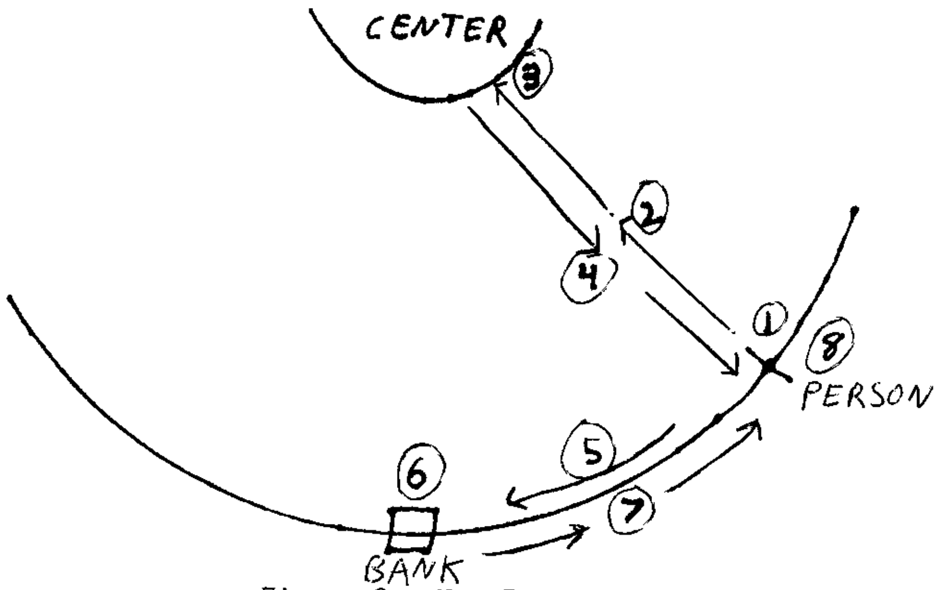

Figure 3: New Transactions Sequence

using its own type of clam. Providing the information needed in such a situation requires resources. If someone offers to buy your mangoes for 5 blue clams you must know what a blue clam is worth. When you offer 10 red clams for an orange, its seller must appraise your money. Whether the market will evolve books describing each clam and its value, or induce experts to abandon picking fruit and offer their services, some real cost proportional to the number of monies will be paid for this diversity. The new equilibrium contains fewer banks because islanders walk slightly farther but engage in less costly trade having fewer monies to compare. Trips to the local bank will still occur because other clams cannot be held overnight (and because the bank provides services) due to a higher depreciation of foreign clams. There can be several reasons for this: tribes inflate the money supply with transfers to tribe members, forcing outsiders to bear the brunt of siegnorage, or perhaps clams have a homing instinct and escape in the night. Either way, the islanders exchange the diverse clams accumulated during the day's trading for own money clams at the local bank.

This part of the example illustrates the costs of multiple monies. In a modern economy we expected people to be able to hold a particular money. Such monies circulating side by side imply·transactions would involve the information costs of ascertaining the value of the money used. This added cost will reduce the number of currencies as traders put up with a slightly worse money in exchange for lower information costs. People closer to the new banks than old banks, however, will be much better off. Hence the island nations of the Carribean forgoe their unique currencies in an attempt to attract U.S. tourists.

SECTION 2

This section introduces the consumer preferences and production opportunities of the model, setting the stage for the analysis of the economy's equilibrium in section 3 below. This section begins by providing a verbal discussion of the model devoid of exchange costs, intended to familiarize the reader with the concepts used to analyze a monopolistic competition economy with heterogeneous monies and decreasing costs. It then proceeds to a formal treatment of consumers and, later, producers.

Lancaster's simple general equilibrium set-up has two industries. There are group (that is, differentiated) goods, and there are outside (or homogeneous) goods. That is, the group market consists not of one good, but of a great many similar goods (for example, radios) all of which have a lot in common with each other, but nothing with the outside good (say, wheat). For the purposes of this paper, the group good is money. Each group good embodies a different amount of the same characteristics (none of which are shared with the outside good). Consumer preferences are over these characteristics, not the goods themselves,[1] which serve only to transfer the more fundamental characteristics.

The production side of this economy differs from traditional competitive models in several way. In the current set up firms have decreasing costs of note issue. Therefore, with a continuous distribution of consumer tastes, a firm with a particular given specification has an incentive to attract a finite segment of the market. Possibilities of strategic interaction, market power, and less than perfectly elastic demand become manifest. In the model, firms must also select 'type' as well as quantity. Each bank must choose the characteristics of its currency, with this choice being viewed as the choice of location on a circle. In choosing its money specification, the firm must maneuver between rivals on either side in a strategic battle for customers. It should be stressed that these strategic interactions attain prominence precisely because of the existence of economies of scale. Otherwise, each man would be able to hold his own favorite money.

The island example serves to introduce how the characteristics model is analyzed. Assuming two characteristics we specify the characteristics of a particular group good by its location on a circle.[2] A circle is analytically easier and suggestive of the political system and the Lucas-Cass-Yaari monetary system. The spectrum is the circumference of the circle (length of

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[1]This concept may be familiar from hedonic pricing studies. For example, if we do not care about taste, looks or texture, the characteristics of food would be its nutrients, and it would be easy to classify foods (as is done in linear programming texts) by how much protein, fat, and vitamin A they have. A person then does not care for roast beef per se, but may like it for its high protein component. Money's characteristics include convertibility, portability, purchasing power, service flow (automatic tellers, bank statements) and riskiness, among many possible attributes.

[2]The problem of locating on a circle is similar to the problem of locating on a line segment, so it may help to think of the point as specifying the ratio of two characteristics embodied in one unit of the good.

the interval); it tells the full range of characteristics the group good may take on, and as such is a technological parameter. For example, the spectrum for radios grew when the transistor allowed smaller, truly portable machines.

In the island example each native would like to have a bank next to his hut. Similarly, in the formal model, each individual is assumed to have an ideal product, a most preferred money (MPM). Assume a uniform density of consumers along the circle, locating a consumer by his or her most preferred good. Further assume that the group goods are divisible i.e. one may buy any quantity, including fractions of units. Portfolios won't be formed, however, since group goods are not combinable.[3] Nor will buying half a yellow Rolls Royce and half a blue Honda give you a green Mercedes. More prosaically, it means a native must choose a bank and walk there to obtain clams (money).

The compensating function, the amount of a group good yielding the same satisfaction as one unit of the MPM, provides the link between spatial location and preferences. The compensating function is not linear, but convex (an increasing function of the arc distance along the circle) because preferences are over characteristics, not goods.

It is possible to imagine different compensating functions for different most preferred monies. However, for technical reasons, the current discussion accepts the uniformity assumption which posits identical compensating functions. This requires all consumers to have the same utility function up to MPM; the only difference is which money is ideal for which cusumer. This admittedly strong assumption plays the role of a featureless plain in location

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[3]We might make this engoenous by saying it costs too much for a native to walk to more than one bank. Likewise, in the more general model, individuals facing fixed costs of choosing and monitoring banks react by patronizing only one firm.

theory. In the lagoon model, it says that the island has uniform terrain; no mountains increase the transportation costs of particular islanders.

Given the non-combinability of monies and each consumer's MPM, the convex nature of the compensating function makes it apparent that each customer holds only one type of money. The general equilibrium of the system then determines which monies (where along the circle) are produced, how much, their price, and how many firms produce a given variety.

This paper adds exchange and information costs to the increasing returns to scale and the heterogeneous products of standard monopolistic competition theory. Any seller, when offered a money, must identify and ascertain the value of that money, and that takes resources, time, and effort. These are not search costs, though mathematically they resemble the durable goods search costs of Parks (1974). Additionally these costs increase proportionately to the number of monies in the market. Intuitively, we expect higher search costs if there are more things to check, fatter catalogues, or thicker bank note reporters. Formally this section extends Helpman's version of the differentiated products model of Lancaster. There are two goods in this economy. Money is the group, or differentiated commodity, and food is the outside, or homogeneous commodity. In order to make sense of the firm's choice problem we must first attend to the consumer.

CONSUMERS

The location of the MPM's (Most Preferred Money) represents individuals who are uniformly distributed around a circle. Each individual uses only one money, itself denoted by its position on the same circle of circumference 2. The consumer may be thought of as sitting at one point on the circle, but holding the money of a different point. Formalizing the uniformity assumption, let each consumer have the identical, homothetic, utility function

$$u(x, y)$$

with x representing the ideal money (MPM) for the consumer. Putting money directly in the utility function is only a second best solution. Unfortunately, the complications of combining monopolistic competition with an acceptable monetary model (such as Townsend (1980)) are quite formidable. Define the compensating function, h(v), on [0, 2] as x(MPG) ~ h(v)x for a good arcdistance v from the MPG. Here we will posit the following form for h(v) but note that Lancaster (1979) derives the restrictions from standard preference axioms applied to characteristics.

$$h(0) = 1 \quad h(v) > 1 \quad \text{for } v > 0$$

$$h'(0) = 0 \quad h'(v) > 0 \quad \text{for } v > 0$$

$h''(v) > 0$ for $v >$ or $= 0$. Figure 4 shows the general shape of h(v).

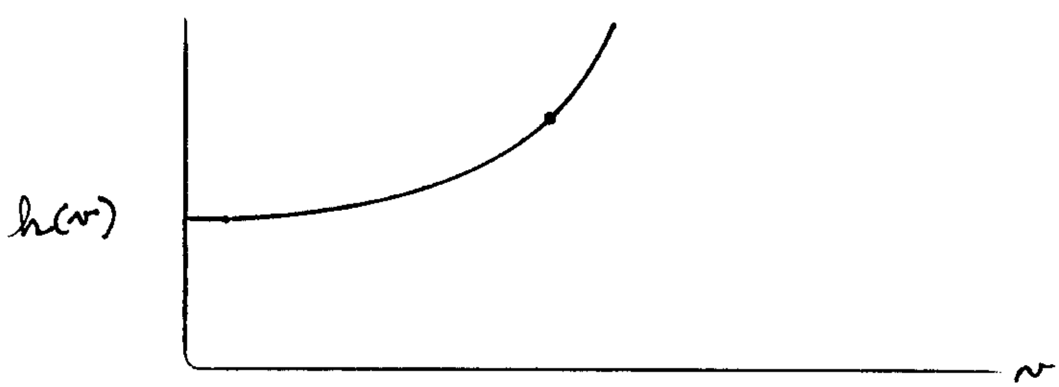

Figure 4: A compensating function

with x(v) the amount of money a distance v from the MPM utility is

$$u = u\left[x(v)/h(v),\ y\right]$$

At this point information and exchange costs enter the problem. In a multiple money world, a consumer must grapple with the many different price levels and exchange rates. In particular, with more currencies around, individuals must spend more income on monetary information. If there are N monies the cost of holding a money is $(1 + Nk)p_x$ where k is a constant and p_x is the price of that money. $(1 + Nk)$ acts like a tax on the money industry: it can't be avoided by holding a different money. Following Auernheimer, Baily, and Calvo p_x is taken to be the inflation tax: the difference between the inflation rate and the nominal interest rate of the particular money in question. The consumer's maximization problem is then

$$\max \quad u[x(v)/h(v), y]$$

subject to

$$p_x x(v) + p_y y + p_x nkx(v) = I$$

Or

$$\text{if} \quad x' = x(v)/h(v)$$

$$\max \quad u[x', y]$$

subject to

$$(1 + Nk)p_x x(v) + p_y y = I$$

Solving the problem, using the standard method of lagrangean multipliers, and noting the first order conditions:

$$L = u(x', y) - \lambda[(1 + Nk)p_x h(v)x' + p_y y - I]$$

$$\partial L/\partial x = u_1 - \lambda(1 + Nk)p_x h(v)$$

$$\partial L/\partial y = u_2 - \lambda p_y = 0$$

Thus homothetiticy of the indifference curves provides the demand functions.

$$(1) \qquad x' = \alpha_x[(1 + Nk)p_x h(v), p_y]I$$

$$(2) \qquad y = \alpha_y[(1 + Nk)p_x h(v), p_y]I$$

Several things about these demand functions deserve attention. First, (1) gives demand for units of the ideal type, that is, demand in MPM equivalents. Furthermore, the term $p_x h(v)(1 + Nk)$ is the implicit or effective price of a differentiated product. An agent holds neither the least expensive nor his most preferred currency, but the money with the lowest effective price (1 + Nk) is common to all goods). Next, the income effect implies α_x and α_y are homogeneous of degree (-1). Finally, the uniformity assumption was created precisely to allow the above analysis to hold for all L consumers, distributed uniformly at a density z around the spectrum.

PRODUCERS

Now consider the production side of this simple monetary economy. Just as consumers have preferences over characteristics of money, banks are able to choose the characteristics that inhere in their money. The interplay between this product choice and the cost (on both the supply and demand side) furnishes much of the model's value added. In particular it enables coherent discussion of scale economies and the inconvenience of many monies. The differentiated products world has two major industries each with its own representative production and cost function. The wheat (homogeneous product) farmer's production and cost functions are

$$Y = F_y(L_y, K_y) \quad C_y(w, r, Y) = c_y(w, r)Y$$

where Y is the quantity of food produced and C_y and c_y are the total and marginal costs of food. The food industry is CRS so that MC = AC, or $P_y = c_y$ in equilibrium. The production function is assumed to be increasing, twice differentiable, linearly homogeneous and strictly quasi-concave.

The banking sector exhibits economies of scale in its production and cost functions

$$X = F_X(L_X, K_X) \qquad C_X(w, r, X)$$

F_X is also twice differentiable, increasing and strictly quasi-concave. A compact expression for the degree of economies of scale is given by

$$\Theta(w, r, X) = C_X(w, r, X)/C_{XX}(w, r, X)X = AC/MC$$

$\Theta > 1$ implies local economies of scale at output level X while $\Theta < 1$ implies local diseconomies of scale at X. In the banking industry $\Theta(w, r, 0) > 1$ and is non-increasing. This general form encompasses a great many types of scale economies: U shaped cost curves, cost curves with fixed costs and constant, increasing, or decreasing marginal cost, etc. The form specifies only that there exist some scale economies for some range of output around 0, and that such economies do not increase with X.

(3) $$\Theta > 1 \quad \text{for } X \text{ in } (0, \bar{X})$$

$$\partial\Theta/\partial X < 0$$

The banking firm's choice problem is to maximize profit by choosing the appropriate output level, rental price, and product specification given the choices of the other firms.[4] This translates to a concern about (i) location and (ii) market width, the measure of the line segment over which a bank's money is held. Firm i locates at point b_i, his neighbors at b_{i-1} and b_{i+1}. For now, assume that only a single firm resides (produces) at b_i. If any consumers buy from firm i then the following inequality must hold

$$p_{xi} \leq \min\left[p_{xi-1}h(v_{i-1}),\ p_{xi+1}(v_{i+1})\right]$$

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[4]We assume no price discrimination, or collusion.

where v_{i-1} measures the arcdistance from b_i to b_{i-1}. The transactions cost term disappears in questions of market share. An individual chooses between the two adjacent monies on the basis of effective price. Each effective price, however, reflects the same (1 + Nk) exchange cost term and therefore is not relevant to the choice between two firms.

Further investigation of market width requires the introduction of several new variables. Define $\bar{d}_i$ implicitly via

$$p_{xi}h(\bar{d}_i) = p_{xi+1}h(v_{i+1} - \bar{d}_i)$$

and $\underline{d}_i$ similarly. Let $\bar{b}_i$ be the point at arcdistance $\bar{d}_i$ from b_i, that is, the point whose cosumer is indifferent between good b_i and b_{i+1}. $2D_i$ is the arcdistance between b_{i-1} and b_{i+1} or $v_{i+1} + v_{i-1}$. Figure 5 illustrates these relationships.

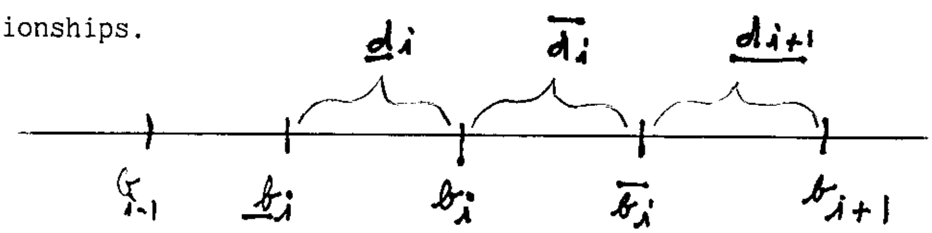

Figure 5: Market Width

The functional relationships for market width are given in (4) and (5)

(4) $$\bar{d}_i = \bar{d}\,(p_{xi}, v_{i-1}, p_{xi-1}, p_{xi+1}, D_i)$$

(5) $$\underline{d}_i = \underline{d}\,(p_{xi}, v_{i-1}; p_{xi-1}, p_{xi+1}, D_i)$$

It can be shown that

$$\partial d/\partial p_{xi} < 0\ , \quad \partial\bar{d}\,/\partial v_{i-1} < 0 \quad \text{and} \quad \partial\bar{d}/\partial v_{i+1} < 0$$

The demand facing firms i will be a function of both market width and market depth. Consumers not only may hold more or less of i's money (consuming more food) but may leave his market entirely. Demand facing the firm at b_i is also a function of rival's prices, the outside good price, the size of the two half markets above and below b_i, transactions costs the population density.

$$Q\left(p_{xi},\ v_{i-1};\ p_{xi-1},\ p_{xi+1},\ D_i,\ zI,\ (1+Nk)\right) \tag{6}$$

$$Q = zI\{\int_0^{\bar{d}} (\cdot)\alpha_x\left[p_{xi}h(v)(1+Nk),\ p_y\right]h(v)dv$$

$$+ \int_0^{\bar{d}} (\cdot)\alpha_x\left[p_{xi}h(v)(1+Nk),\ p_y\right]h(v)dv\}$$

The existence of the location parameter means that the firm has two strategic variables, price, p_{xi}, and specification, v_{i-1}. Likewise, consumers may respond to a rise in p_{xi} either by holding less money or by switching brand loyalties.

Firms are assumed to maximize profits. The problem for each bank is to maximize profits given (i) a price of food and (ii) prices and specifications of all other monies. This will lead naturally to a Nash equilibrium in section three below. Analytically, the problem is

$$\Pi_i = p_{xi}Q(\ldots) - C_x\left(w,\ r,\ Q(\ldots)\right)$$

First Order Conditions are

$$p_{xi}\partial Q/\partial p_{xi} + Q - C_{xx}\partial Q/\partial p_{xi} = 0$$

$$p_{xi}\partial Q/\partial v_{i-1} - C_{xx}\partial Q/\partial v_{i-1} = 0$$

or, rearranging terms and simplifying things a bit, we find that the first order conditions become

$$p_{xi}\left[1 + Q/p_{xi}\partial p_{xi}/\partial Q\right] = C_{xx} = p_{xi}\left[1 + 1/E\right) = C_{xx} \tag{7}$$

(8) $$[p_{xi} - C_{xx}]\partial Q/\partial v_{i-1} = 0$$

$E(\cdot) < 0$ so (7) implies $[p_{xi} - C_{xx}] > 0$ so by (8) $\partial Q/\partial v_{i-1} = 0$. This is a Wong-Viner effect in specification choice. At the optimal location, a change in position along the circle has only second order effects.

The second order conditions must also be satisfied. That amounts to making sure that

(A) $$\frac{\partial^2 \pi}{\partial p_{xi}^2}, \frac{\partial^2 \pi}{\partial v_{i-1}^2} < 0$$

(B) $$\left(\frac{\partial^2 \pi}{\partial p_{xi}\partial v_{i-1}}\right)^2 < \left(\frac{\partial^2 \pi}{\partial p_{xi}}\right)\left(\frac{\partial^2 \pi}{\partial v_{i-1}^2}\right)$$

A and B are necessary and sufficient conditions for the second order conditions.

SECTION 3: EQUILIBRIUM IN A CLOSED ECONOMY

This section presents the equilibrium of the economy, laying the groundwork for section four's explorations into policy and history behind private money. Moreover, the equilibrium, tells us bank size, consumer holdings, market width, number, location (specification) and price of money. The equilibrium is found using a two step procedure. First, hold fixed the number of banking firms and find the location and prices of monies. Next, allow entry to determine the competitive number of monies; once that number appears the previous result determines prices and specifications. A simple example allows some comparative statics to be done.

This paper explores a Nash equilibrium[5] in two parts. The procedure first fixes the number of firms and determines the price and specification equilibrium. Next, it imposes zero profits as a long run equilibrium condition and determines the free entry equilibrium number of monies using the results of the first exercise.

In considering a non-cooperative solution with an unchanging number of firms, we conjecture an equilibrium and show it is Nash Equilibrium in the short run. The trial solution is to have all firms spread symmetrically around the spectrum, charging the same price. The arcdistance between any of the N banks is $D = 2/N$. Notice (4) and (5) imply that monies are spaced symmetrically only if prices are all the same. Equation (6), evaluated at this trial equilibrium, yields

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[5]In determining the non-cooperative equilibrium of this economy we provisionally ignore two possible strategies of firms. The first is that firm may drastically cut prices in an attempt to capture its neighbor's entire market. This adds an element of discontinuity into the problem that must be explicitly dealt with. Such an attack adds a lot of complexity without shedding much light on the issues involved. Furthermore, it has been shown that in location models such a strategy is not profitable and does not disturb equilibrium. The location models use what is essentially a linear compensating function. The convex compensating function of the characteristics model makes such strategies less attractive; the price required to gain a neighbor's market is even lower. That is, in the Hotelling models an effective price lower than i+1's at i+1's location means i obtains the entire market. With convex h(v) people in i+1's market still buy form i+1; they like the money better. The second strategy ignored is popularly called 'jump and cut.' It involves a firm changing location (specification) to directly on top of another firm--producing exactly the same product--and charging a slightly lower price. The competitor will retaliate, and a Bertrand equilibrium will result, each firm charging cost and making no profits. It will then benefit each firm to move back to the original position of differentiated products, and the cycle begins again. Obviously, no equilibrium results. The above problem has been fruitfully ignored for years. In the theoretical literature there have been some attempts, none totally satisfactory, to resolve this conundrum, such as letting each firm vary its product only infinitesimally, or to adopt what is called a modified zero conjectural variation approach. Other subtle devices have been tried. This paper assumes the problem away.

(9) $$Q(\cdot) = 2zI\int_0^{1/N} \alpha_x[p_x h(v)(1 + Nk),\ p_y]h(v)dv$$

Since the exchange externality term does not affect market share decisions we may employ the results of Helpman (1980) and Lancaster (1979). Specifically, Helpman's appendix proves that $\partial\bar{d}/\partial v_{i-1} = -1/2$ and that $\partial\underline{d}/\partial v_{i-1} = 1/2$, implying $\partial Q/\partial v_{i-1} = 0$, which in turn means that the profit maximizing condition[6] (8) is satisfied. That is, at the profit maximizing point, a small change in position means the firm loses just as many paying customers on one side of the market as it gains on the other.

LONG RUN

Finding the long run number of firms is now straightforward. Using Leibniz's Rule, one may calculate the elasticity of demand at an equilibrium point, $\tilde{E}$. We know that $\tilde{E} < -1$ because no rational business would operate on an inelastic portion of its demand curve. Each supplier has some degree of monopoly power over people who prefer that money; we are in the arena of monopolistic competition. This power depends on, among other things, how many substitutes exist for the company's product. A standard measure of such monopoly power is

(10) $$R = p/mr \quad \text{or} \quad R(p_x, p_y, N) = 1/(1 + 1/\tilde{E}) = \tilde{E}/(1 + \tilde{E})$$

As $N \to \infty$ what happens to $\tilde{E}$? $h'(1/N) \to 0$ as $N \to \infty$ but while the compensating function flattens out as its argument approaches zero the effect of the search appears ambiguous. R is approaching 1 and following the policy of Helpman (for the present) we assume R is declining in N (we will later prove it for a simple case). This restriction makes some sense for we do not expect every

[6] This is the Wong-Viner condition.

market to exist. Demand functions and technologies may preclude a viable market for the group involved.

In this long run case free entry and free exist occur, subject to a zero profit condition.

(11) $$p_y = c_y y \quad \text{recall} \quad C_y = c_y y$$

(12) $$p_x x = C_x(w, r, X)$$

For the farmers producing under a CRS technology, price equals marginal cost equals average cost. For the group produces mr = mc is a separate condition, equation (8). Putting (8) and (12) together and using the definition of R and Θ we find the long run equilibrium condition

(13) $$R(p_x, p_y, N) = \Theta(w, r, X)$$

The degree of monopoly power equals the degree of economies of scale. This involves balancing the effects of prices, quantities and number of firms. Finally, equilibrium requires that supply equals demand for all x and y. For a particular monetary variety of x equation (9) gives the equilibrium demand $X = 2zI\int_0^{1/N} \alpha_x[\,]h(v)dv$. The set of consumers who hold one variety of money also consume Y/N units of food so that

$$Y/N = 2zI\int_0^{1/N} \alpha_y[\,]dv$$

so that the condition that must be fulfilled is

(14) $$\int_0^{1/N} \alpha_x[\,]h(v)dv \;/\; \int_0^{1/N} \alpha_y = X/Y/N = NX/Y$$

An economy in equilibrium satisfies (13), (14) and $N = n$. Provided each firm produces only one good and (13) holds, then the candidate Nash equilibrium also satisfies (14) and thus is a full equilibrium for the differentiated products economy.

There is no reason, or even presumption that (13) is satisfied by $N = 1$. The full import of (13) is left for section 4 but it bears nothing here that even with decreasing costs and the transactions burden of many currencies, there is no reason to suppose a 'natural monopoly' in the note issuing business. Moreover, since R decreases (in N) towards 1 and θ decreases towards 1 (in Q) there are unexploited economies of scale. This is perfectly all right, because taking advantage of those economies would not be profitable. However, doing so would benefit agents close to the bank, so strong incentives for government intervention exist. This line of inquiry is pursued in section four.

Can we be sure that each bank produces a different money? Consider the equilibrium we have just examined, but assume that two banks produce the same product (the point is made even more strongly if there are more) and share the market according the proportion λ and $1 - \lambda$. The spacing between goods is D so that the quantities sold by the firms are $2\lambda Q[(1/2)D]$ and $2(1 - \lambda)Q[(1/2)D]$. Now suppose the firm with share λ changes the specification of its good by 2σ in either direction. The firm now has its own market, since all prices are the same. The nearest firm on the 'away' side (away from the $1 - \lambda$ firms) is $1/2[D - \sigma]$ and the equal prices guarantee the market boundary is the half-way point, or $1/4[D - \sigma]$. On the side facing the old partner the market will be $1/2\partial$. Total sales for the firm that has moved will be

$$Q\left[1/4(D) - \sigma\right] + Q(\sigma)$$

but stability in the market requires that Q be at least weakly concave, implying

$$(15) \qquad Q\left[1/2(D)\right] \leq Q\left[1/4(D) - \sigma\right] + Q(\sigma)$$

that is, sales increase if $\lambda \alpha 1/2$ and Q is strictly concave and are unchanged if $\sigma = 1/2$ and Q is linear. Price has not changed and average cost is falling since $\Theta = R$ and $R > 1$ (this used to be called 'excess capacity'). A firm with less than half the market (or not more than half if demand is strictly concave) increases sales, decreases average costs, makes higher profits by moving. The firm that has not changed its product finds market width to be (1/2)D on the far side, σ on the near for a total sale of

$$Q\left[(1/2)D\right] + Q[\sigma] > 2(1 - \lambda)Q\left[(1/2)D\right] \quad \text{if } \lambda > 1/2$$

Thus, whatever the original division of the market at least one firm gains by a move of 2σ. Once the firms have moved apart, however, the normal first order conditions (7) and (8) apply, inducing the firms to spread out evenly along the circle.

The equilibrium examined in this paper predicts the equilibrium difference between inflation and nominal interest rates (as the cost of money), the number, and characteristics of monies produced. If tastes over nominal quantities are assumed, then the model easily predicts the equilibrium inflation and nominal interest rates.

A SIMPLE EXAMPLE: COBB-DOUGLAS UTILITIES

This section uses a Cobb-Douglas utility function to attack the comparative statics problem of changes in k, the information and exchange cost parameter. Such simplification is common--Lancaster, without an externality, assumes a Constant Elasticity of Substitution utility function. In light of the extreme properties of Cobb-Douglas utility we should emphasize that this provides an example fitting the general constraints that Helpman imposes. As such, the Cobb-Douglas form simplifies calculations but does not itself play a crucial role in the results. Granted that R is decreasing in N, it is still unclear what the effect of a decrease in k will be on the equilibrium number of monies in the system. Intuitively lower transactions costs imply more monies; trading with many currencies becomes easier. A rational islander may well walk miles if his simple accounting scheme is strained by five types of clams, but when someone invents the ledger book long distance hikes will not be worth the time. With the number of firms fixed in the short run, inspection of equation (9) makes the answer the clear. As k decreases Q increases due to a reduction in effective price. Higher output reduces cost, higher demand allows price to rise, so profits rise. With positive profits occurring entry will occur. The long run case is technically a bit more difficult, hence the need for a simple utility function.

The consumer's maximization problem is the same as before

$$\max\ (x')^{\alpha} y^{1-\alpha} \quad \text{subject to}$$

$$p_x h(v)(1 + Nk)x' + p_y y = I$$

solving the lagrangean involves finding

$$[\alpha/(1 - \alpha)]y/x' = p_x h(v)(1 + Nk)/p_y$$

and solving into the budget constraint to get

(15) $$x(v)/h(v) = \alpha I/[p_x h(v)(1 + Nk)]$$

(16) $$\alpha_x = \alpha/[p_x(1 + Nk)]$$

The plan is to calculate $\tilde{E}$, the equilibrium elasticity of consumption and differentiate it with respect to k, the exchange costs parameter. The shift in $\tilde{E}$ is what shifts R. θ adjusts to k only as a reaction to the change in R, k being a demand, not a supply variable. Bringing in a result from before, we know the value of $\tilde{E}$ is

$$(17) \qquad E\sim = \{p_x \int_0^{1/N} \alpha_{x1}[p_x h(v)(1 + Nk),\ p_y][h(v)]^2(1 + Nk)d$$

$$-(1/2h'(1/N))\alpha_x[p_x h(1/n)(1 + Nk),\ p_y][h(1/N)]^2(1 + Nk)\}$$

divided by

$$\int_0^{1/N} \alpha_x[p_x h(v)(1 + Nk),\ p_y]h(v)dv$$

where α_{x1} denotes the partial derivative of α_x with respect to the first argument. Using (15) and (16) find the Cobb-Douglas version of (17)

$$(18) \qquad p_x \int_0^{1/N} [-\alpha/[p_x(1 + Nk)]^2][h(v)]^2(1 + Nk)dv$$

$$-[1/2h'(1/N)][\alpha/P_x(1 + NK)][h(1/n)]^2(1 + Nk)$$

divided by

$$\int_0^{1/N} \{\alpha/[p_x(1 + Nk)]\}h(v)dv$$

(18) is then differentiated with respect to k. After simplifying the result is

$$= -\{\alpha^2 N/[2h'(1/N)][h(1/N)]^2 \int_0^{1/N} h(v)dv[p_x(1 + Nk)^{-2}\}$$

Since h and h' are always non-negative (19) is negative. $R = \tilde{E}/(\tilde{E} + 1)$ so $\partial R/\partial k$ is also negative, implying that as k falls R rises, that is, as exchange costs decrease the long-run equilibrium number of monies increases. The intuition is obvious: as transactions costs decrease, the demand for money increases, supporting more firms. Natives can now afford the luxury of near-by banks. We must be careful here. The above result is valid only if $\partial \tilde{E}/\partial N < 0$. Fortunately, that can be shown at least asymptotically. It may be possible to make the result even stronger.

SECTION 4: APPLICATIONS

This section uses the model developed in section 2 and 3 to critically examine (i) a particular argument for a money monopoly, and (ii) the political economy of government intervention in the money supply process.

INEFFICIENCY OF INTEREST BEARING NOTES

We first investigate a speculation of Robert Barro concerning the ban of interest payments on money. Assume that the optimal number of monies is one (this may result from large economies of scale). It is difficult, that is, costly, to pay interest on circulating currency. Nevertheless, if only one firm were producing money another firm could threaten to enter the market, pay interest on currency and gain the entire market. The high cost of paying interest would make this outcome Pareto inferior, encouraging a public minded government to outlaw payment of interest. One view is that this is the standard quickly declining marginal cost principle underlying the regulation of public utilities. The entering firm is in effect bribing customers by accepting a lower monopoly rent. This is especially clear if money is held only to satisfy a cash in advance constraint, in which case the interest payments ar a redistribution only. If it is not, then the differentiated products model calls Barros' analysis into question, however. First, consider the potential strategies of the entering firm. The optimal strategy is not to pay interest but, rather, to inflate at a lower rate that the existing firm (provided the relevant consumer price consumers is $(\Pi - R)$, and if, as postulated, the costs of paying interest are high). The new firm captures the entire market because it charges a lower price for the same product. An interest payment will only give it part of the market, as some people (for tax reasons, say) won't want their purchasing power given as an interest payment.

Since the main cost of paying interest consists of keeping track of and augmenting the money properly, it is independent of the level of interest paid. Consequently competition would appear in other areas, especially since it would be so easy to undercut the inflation rate of the other firm. Knowing that money is valued for many characteristics lends credence to Milton Friedman's argument that firms will give out kewpie dolls, electric fry pans, or change the convertibility of their money to implicitly remove the ban on interest payments. The Barro story reflects a lack of appreciation for the existence and trade offs involved in a differentiated products market (or perhaps keener insight into the defects of the Lancaster-Chamberlin Paradigm). Interest payments make a money different, not better. An entering firm chooses a point on the money circle. Just because that point means the firm will pay interest does not given the firm any special advantage, just as a green car need not dominate a red car. Fundamentally paying interest (in this model) amounts to producing a different colored car, not (say) bringing out an all around superior auto. Even by locating 180 degrees opposite, at the north end of the island, the entering firm will gain only half the market--clearly a far cry from driving the other firm out. The Barro analysis does not recognize the many aspects of money and accordingly that it is inappropriate to model an entering firm as simply adding interest payments. Rather, a firm chooses a particular specification for its notes. Adding interest payments involves decreasing the amount of some other characteristics. A firm paying interest on money is apt to have a less liquid cash (perhaps less acceptable at shady dealings) which some will not like.

EFFICIENCY OF COMPETITIVE EQUILIBRIUM

One point raised by the above discussion stands out; we have not determined the optimal number of monies. It may happen that too many monies exist. A priori there is no firm reason to suspect that a competitive system will reach the optimal trade off between variety and economies of scale. Lancaster poses the problem in the following way: what is the least costly arrangement of firms that allows individuals to attain a specific utility level. The answer is complex, but there is a presumption that there will be too many monies in circulation. The unrestricted market system over values variety at the expense of productive efficiency. Lancaster warns against justifying government action on that basis alone, however, because the presumption is only that, a presumption. It may be that there are too few firms in operation. Additionally, reaching the social optimum requires a detailed knowledge of technology and preferences to guide a complicated redistribution scheme. Given the uncertainty about both direction (subsidy or restriction) and degree of government policy, one must be skeptical about the scope for beneficial intervention.

The exchange costs added in this paper add more complexity and ambiguity to the problem. To the extent that one person's use of a money increases the value of that money to others, an externality suggests an overabundance of currencies. To the extent that the exchange cost increases the effective price of a money demand for that money is less, however, this forces fewer currencies.

A POLITICAL ECONOMY OF GOVERNMENT INTERVENTION

This sub-section contains speculations toward a positive theory of government intervention in the money supply process. As we have seen in section three, one distinguishing feature of the differentiated products model is production at a point above minimum average cost (since $\theta > 1$ in equilibrium). The model presented in this paper has the additional feature that the number of firms increases costs to the consumer. In general, consumers whose ideal money is similar to a money being issued have an incentive to outlaw other firms, allowing the "close" firm to take advantage of economies of scale and benefit from the reduced exchange costs. Consider the island parable. The social optimum may not be clear, but for islanders near a bank the cost reducing investment will be beneficial. On the circular atoll, some natives near banks may form a coalition outlawing some other banks, thus reaping benefits of less expensive clams and lower transactions costs. Opposition to the scheme will come from islanders forced to walk farther under the new system (or, more properly, the net losers, taking into account the reduced transactions costs). A reduction in the number of banks (say from 4 to 3) induces banks to relocate, as they attempt to stay evenly spread around the island. This will upset people originally near a bank but will delight those at the bank's new position. Thus political squabbles will occur not only about legislation dictating the number of banks but over legislation dictating the location (specification) of banks as well.

This hypothesis fits the stylized facts of monetary history better than the now standard Stigler/Peltzman (1976) theories which focus on the owners of industry gaining at the expense of unorganized consumers. As Gary Becker

(1976) has pointed out, a great deal of current regulatory theory assumes that the amount of social deadweight loss increases with the amount of benefit to the favored party. This need not be the case with Lancaster's theory. It may be optimal to reduce the number of firms in the industry because of the inefficiency of competitive equilibrium mentioned above. Following Lancaster's suggestion does not exclude the Stigler/Peltzman theory but does provide a different perspective. Our hypothesis perceives regulation not as a fight between producers and consumers, but between different groups of consumers striving for establishment of their favorite money (or good). This coincides with the history of the debate over government intervention in the money supply process.

The conflict between debtors and creditors explains much of American monetary history but it becomes apparent in works such as Hammond (1957) that this interpretation becomes strained at many points. Part of the problem may stem from the common confusion between money and credit. The theory of this paper should manifest itself most clearly in the politics surrounding bank charters, involving the number and location (and type) of note issuing banks.

The government has often limited entry to the banking and note issuing sector. Hammond (1957) describes

> The earliest of these, in New York, had been enacted in 1804, when the Federalist legislature made it illegal for a person "unauthorized by law" to be a proprietor of a bank or member of a banking company. There had been at the time six chartered banks in the state besides an office of the Bank of the United States. In 1813 and 1818 the restraint had been restated and strenghtened; . . . . The object of these acts according to the state Supreme Court . . . was to assure chartered banks "a monopoly on the rights and privileges granted to them, which had been encroached upon or infringed by private associations."

Chartered bankers supported such laws, but so did much of the non-bank public. Rather than chalk this up to the agrarian suspicion of banks and bankers one should recognize that these individuals hope to gain from the establishment of their most preferred bank. This straightforward economic reasoning makes sense of the puzzing coalitions of populists and bankers continually forming in the Nineteenth Century. For instance, Hammond notes "In 1835 another attempt was made to repeal the restraining laws, but the Loco Focos joined the chartered banks to defeat it, preferring monopoly to the flood."

The public and the government also expressed concern over the characteristics and location of banks with words and legislation. Hammond cites a clear instance of this in Iowa.

> Before the constitution was ratified, a critic had pointed out that with no banks of its own the state would find itself buying and selling with the paper issues of banks in other states. Iowa would become "the plunder ground of all the banks in the union," he declared. "Instead of the hard money promised to people, we shall have not only a hard currency but one well mixed, ... Instead of a currency free from expansion or contraction, as hard money is alleged to be, we shall have a circulation constantly liable to exploitation and irredeemable in its character.

In other cases the beneficiaries of more banks were on the willing side. Again, Hammond notes

> So the number grew. Each borrowing interest wanted a bank of its own. Soon as Dr. Rush said, banks were serving not only merchants but "mechanics," . . . . The charter of the Washington Bank, Westerly, Rhode Island . . . declared that "those banks which at present are established in this state are too remote or too confined in their operations to diffuse their benefits so generally to the country as could be wished."

Many restrictions hobbled chartered banks, and often restricted the natural responses to changing numbers and types of competitors, as the differentiated products model predicts they will. Capital requirements, loan restrictions, and regulations on note issuing frequently found their way through the state assemblies. State governments also found it necessary to legislatively define banking activities both to impose these strictures on chartered banks and to prevent the emergence of unchartered rival banks. These political and legal pressures were real. Hammond reports "Yet whenever a chartered bank sought to renew its charter, reduce its capital, or even move from one address to another, it was carped at as a 'privileged body.'"

Work by John A. James on banking in postbellum America corroborates the monopolistic competition interpretation of antebellum financial politics. As James stresses the local monopoly power of spatially (and characteristically) separated banks, his study provides a convenient example of a monopolistically competitive economy.

How well does the theory predict features presented by James? There were certainly strong restrictions on National banks. Capital requirement were very high: 50,000 dollars in small towns, 100,000 in cities. The imposition of an entry condition so closely related to size immediately suggests scale economies as a driving factor. The capital requirements also served to keep the national banks in larger towns, in some sense fixing their location. Legislation also specified some of the banks' other characteristics, specifically prohibiting mortgage lending. In addition, banks could issue notes only on government securities. State and private banks, subject to less stringent rules, eventually entered the market.

There appears to be an observational equivalence problem here, for conventional theories of regulation also predict entry limitation. Several facts argue for the Lancasterian version, however. First, intervention occurred in the distribution (location and specification) of banks. Secondly, consumers became involved in the decision process, holding rallies, forming parties, and publishing periodicals. It seems unlikely that theories stressing the trade off between large gains by regulated industries and the consequent small losses to individual consumers will ever adequately explain the politics of American monetary policy. Hammond describes a scene where the repeal of a bank's charter set off a riot. Finally, intervention seemed concentrated on the number and distribution of firms, not any joint profit maximizing restriction of output such as occurred with airline regulation.

Defining money as a bundle of characteristics gives politicians more things to fight over, trade off, and logroll. we would expect to see people fighting, not just for their particular industry, or over the number of monies in the system, but over the specification of those monies as well.

CONCLUSION

This paper has used the monopolistic competition framework to establish two basic points. The first is that with decreasing costs of note issue, differentiated money valued for its characteristics, and exchange and transaction costs, there is no presumption for a natural monopoly in currency issue. The equilibrium number of currencies was established, and was shown to depend upon, among other things, the size of the exchange cost. The second major point is that the desire for less expensive currency due to fuller exploitation of the economies of scale in note issue and the desire for lower transactions costs in exchange provide incentives for political intervention into the money supply process, both in determining the number of currencies and in defining the characteristics of the monies allowed. It was suggested that such factors played a role in U.S. Monetary history.

Concern over economies of scale and the inconvenience of many monies has a long history. This model has shown itself able to address some of those concerns.

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