Incomplete

Interconnection and Rivalry between Banks

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Abstract: This is an incomplete draft of a paper that will examine the competitive tension that arises when banks which compete for deposits provide "interconnecting" payment services to each other's depositors. This draft presents a basic theoretical model and discusses some of the analysis that can be carried out and issues that can be addressed with the model.

[1] This work was undertaken while the author was a visiting scholar at the Institute for Monetary and Economic Studies at the Bank of Japan. The views expressed herein are the author's and do not represent the views of the Federal Reserve Bank of Richmond, the Federal Reserve System, or the Bank of Japan.

Economists studying the theory of banking have typically focused mostly on the role of institutions in intermediating between savers and uses or users of savers' funds. Recently, however, some economists have begun to turn their attention to the payment function of banks.[2] The nature of this function and the way in which depository institutions can play this role may depend on various features of a fully articulated economic model. Specifically, limits to information, communication and commitment are likely to be important in determining the set of feasible payment arrangements. At its heart, however, the payment function of banks has a very simple fact; carrying cash is costly. In a commodity money economy in which exchange occurs at diverse locations and times, there may be real resource costs associated with always having enough cash on hand to meet one's needs. Similarly, in a fiat money regime with positive nominal interest rates, carrying money imposes on agents the opportunity cost of forgone interest income. Hence, any institution that allows agents to store their wealth (preferably in a form that earns a positive return) is potentially beneficial.

Storage at a fixed location raises the question of how to make payment for consumption that occurs at a location remote from one's storage. One possibility is for the consumer to receive credit, with payment to be sent at a later date. Since technologies for the transport of goods or money are likely to involve common costs, a credit arrangement has the advantage of possibly economizing on the resource costs of sending payment by pooling the shipments of several agents who maintain storage at one location but consume at another.

For some purchases, however, direct credit between the buyer and the seller may not be feasible. The seller's consumption needs may be such that he must be paid in cash at the time of the purchase. A consumer with money stored at a different location will not be able to make such a purchase unless he is able to gain access to the medium of exchange that is stored at the location where he wants to consume. That is, he must enter into some sort of credit arrangement with the storage facility at this location, to be settled later with a shipment from his own deposits. In this case, the provision of payment services requires the coordinated inputs of two storage providers.

[2] A very recent example is McAndrews and Roberds (1999)

When payment requires the input of more than one depository, there is a potential tension between cooperation and competition. On the one hand, by cooperating in making remote payments, storage providers can offer a superior service, for which consumers will be willing to pay more. On the other hand, if customers choose among competing depositories at distinct locations, the terms under which a depository provides payment services to other providers' depositors can be a powerful competitive tool. If an agent thinks that it is likely that he will want to consume at a particular location, and if the depository at that location places a high price on payment services to non-depositors, then the agent will have a strong incentive to place deposits at that location.

This tension between competition and cooperation is analogous to the interaction among providers in competing network communication services. In such industries, a key issue concerns the terms under which one network's customers can connect to those of another network. This interconnection problem has recently been examined in a series of papers by Laffont Rey and Tirole and Economides, Lupomo and Woroch. These papers employ a model of imperfect competition between competing networks in which sellers set prices of within- and across-network services. The strategic use of across-network prices (interconnection prices) introduces distortions that are distinct from the usual market power distortion, and the authors explore the effectiveness of regulatory pricing rules in counteracting these distortions. McAndrews and McAndrews and Roberds have reinterpreted this model in terms of the pricing of interbank payment services.

One prominent feature of the model used in the recent communications literature is the high degree of symmetry in the demand for the underlying services. This symmetry adds greatly to the model's tractability but limits its usefulness somewhat, especially, perhaps, in applications to banking and payments. While the symmetric case might apply reasonably well to the relationship among the banks in a large urban market, the historical instances in which interconnection has become particularly contentious seem to predominantly occur in cases where asymmetry was an important consideration. In the U.S., there are many instances in which the interests of city banks and country banks have diverged on matters of payment clearing and settlement. In Japan, when there was a general effort at forming a nationwide interbank clearing system in the 1940's, the interest in such a system was strongest among the regional banks. The so-called city banks, with extensive internal branch networks, were less interested in such cooperation.[3]

One purpose of this paper, then, is to introduce asymmetry in a tractable way. At the same time, the model presented below develops the interconnection problem within the context of an explicit model of a market for storage and payment services. This results in a framework that can be extended and varied to examine a wide variety of theoretical and policy issues concerning the banking and payment system.

1. The Model

The economy lasts for three periods ($t = 0,1,2$) and consists of two types of agents. There is a continuum of consumers indexed by $z \in [0,1]$ with a constant density. These consumers derive utility from the consumption of two goods, a generic consumption good and a location-specific good. Each agent receives an endowment *w* of the generic good at time zero. This endowment may be stored, as described below, and is consumed in period 2, the final period. In the interim period, period 1, each agent wishes to consume a location-specific good at one of two locations, location 0 and location 1. An agent's preference for location is the result of a shock realized at the start of period 1. An agent's lifetime expected utility is given by:

$$U(z) = f[u(x_0(z)) + y_0(z)] + (1 - f)[u(x_1(z)) + y_1(z)],$$

where f is the probability that the agent wants to consume the location 0 good, $x_i(z)$ is the consumption of an agent from *z* of the location i good, and $y_i(z)$ is the final period consumption of the generic good of a consumer from *z* who consumed at i in the interim period. The utility function *u* has standard characteristics. In addition u(0) = 0.

An agent can consume the location-specific good only if he has stored his endowment with a bank, as described below. An agent may choose to hold his endowment himself. If he does, however, it is prohibitively costly to use his stored goods to purchase location-specific consumption. Hence, if an agent chooses self-storage, his lifetime utility is $u(0) + w - h,$ where *h* is the cost of self-storage.

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[3] Tsurumi (1999)

At each of the two endpoint locations, 0 and 1, there is a single agent with a superior technology for storing the generic good until the final period. These agents, who will be called banks, derive utility only from their consumption of the generic good in the final period.

There are costs associated with transporting the generic good to storage. If a consumer at z chooses to place some endowment in storage with the bank at 0 (1), that consumer incurs a cost of tz ($t(1-z)$). The generic good can also be transported between storage locations in period 2. One can make various assumptions about who has the ability to use this final period transportation technology. As an initial case, assume that only the banks can make such shipments.[4] Alternatively, one might imagine that there are differences in the enforceability of intertemporal payment commitments made by banks and those made by individuals. Specifically, enforcement actions against individuals are impossible while those against banks are costless.

Production of the location-specific good requires input of the stored generic good. One unit of generic good produces one unit of specific good. One can imagine that this production is undertaken by a distinct set of agents who are alive only during the interim period, who derive utility from their consumption, y, of the generic good and disutility from their production, x, of the specific good. These agents, then, will need to be paid out of consumers' deposits. If there are a large number of such producers at each location, then competition will limit producers' profits to zero and the price of the location specific good (in units of the generic good) will be one. The need for settling transactions across locations in the final period, then, arises from the need to pay for all location j specific consumption out of generic goods stored at location j. Some of this consumption will go to consumers who did not place goods in storage at that location.

When an agent consumes at a location where he has no deposits, then payment to producers must come out of the storage that is held at that location. The bank at that location will provide this funding if it expects compensation in the form of a final period shipment of generic goods. There may be costs associated with making such interlocation payments. As shipments for final settlements may be pooled, one might expect the associated costs to be largely fixed relative to the quantity shipped (up to the capacity of a shipment). The costs to the bank that provides interim funding for interlocation consumption may involve, for instance, the costs of communicating payment information to consumers' home bank.[5] Like transportation costs, these costs might also be largely fixed relative to the quantity of interlocation consumption. For the moment, assume that the only variable cost associated with interlocation payments is a cost of c (in units of the generic good, per unit of specific consumption) incurred by the bank providing interim funding.

Banks will seek compensation for their storage and payment services so as to maximize their profits (their final period consumption of the generic good). One can imagine a wide array of pricing terms for bank's services, and this will be the topic of section 3. All pricing terms are announced before consumers make their deposit decisions. The timing of events in the economy are summarized below.

Period 1: Agents receive their endowments.
Banks announce prices.
Agents make deposit decisions.

Period 2: Preference shocks are realized.
Agents travel to desired locations.
Producers are paid with locally stored generic goods.
Location-specific consumption occurs.
Producers consume their payments and disappear.

Period 3: Banks compensate each other for interlocation consumption.
Banks deduct expenses and prices from agents' deposits.
Banks consume their profits.
Agents consume their remaining deposits.

2. Efficient Allocations

[4] This assumption amounts to making the bundling of storage and payment services in the same institutions exogenous. Hence, one might not wish to think of this model as providing a deep theory of why banks provide payment services.

[5] In the model presented here, such information does not really need to be communicated, since it is known how much will be consumed at any given location n (though it is not known ex ante who will consume where). In a model extended to include additional sources of uncertainty, such communication could be important

An allocation in this economy describes the deposit (storage) and consumption behavior of the consumers and the profits (consumption) of the banks. A storage allocation is represented by a pair of functions, $s_0(z), s_1(z),$ giving the amount stored at locations 0 and 1, respectively, by an agent from location *z*. The amounts deposited in storage are limited by the following constraints:

$s_0(z) \le w - tz,$

$s_1(z) \le w - t(1-z),$ and

$s_0(z) + s_1(z) \le w - t$, if $\min[s_0(z), s_1(z)] > 0$.

An agent's consumption allocation is represented by the functions $x_i(z), y_i(z),$ for $i = 0,1$, as introduced above. If $r_i(z)$ denotes payments by an agent from *z* to the bank at i, then agents' consumption faces the following constraint:[6]

$$y_i(z) \le s_0(z) + s_1(z) - x_i(z) - r_0(z) - r_1(z).$$

A bank's utility is simply its consumption of the generic good, which is equal to the payments it receives from agents less the costs it incurs in providing payment services. As specified above, the only such cost is a cost of *c* per unit of specific consumption at i that is not covered by deposits at i. Hence, a bank's profits can be written as

$$\Pi_i = \int_i \{r_i(z) - [x_i(z) - s_i(z)]c\} dz.$$

The welfare criterion by which efficiency will be judged is the sum of consumers' expected utility and banks' profits. Given the linearity of all agents' utility in the generic consumption good, payments from consumers to banks in excess of the costs of interlocation consumption are pure transfers and neither add to nor subtract from welfare. That is, welfare is aggregate expected utility from specific consumption plus aggregate

[6] It is assumed throughout that the specialized producers at each location are compensated one unit of generic good for each unit of specific good produced. Therefore, their profits and utility are zero, and they are ignored in the specification of feasible and efficient allocations.

generic consumption, where the latter is the endowment net of: the costs of making deposits; consumption of the specific good; and costs of interlocation payment.

Given the fixed nature of deposit costs, relative to the amount deposited, small positive values of $s_i(z)$ are likely to be dominated by either larger values or values of zero. One can make this statement with certainty for large enough values of the endowment, *w*.

Let x^* be the level of specific consumption that solves the problem, $\max[u(x)-x]$. Then, if $w-t \geq 2x^*$, efficient storage will always involve one of the following:

$s_0(z) = s_1(z) = 0$;

$s_0(z) = 0, s_1(z) = w - t(1-z)$;

$s_1(z) = 0, s_0(z) = w - tz$; or

$s_0(z), s_1(z) \geq 2x^*$.

The amount x^* is the greatest amount of the specific good an agent will ever consume. It is, in fact, the amount an agent will consume in an efficient allocation if there is enough storage at the location where he is consuming: the marginal cost (in foregone generic consumption) of a unit of specific consumption, when no interlocation flow of payment is required, is just one. When interlocation payment is necessary, the marginal cost of specific consumption rises to 1+*c*. Define x^c as the level of specific consumption solving $\max[u(x)-(1+c)x]$. This will be the efficient specific consumption of an agent who has storage at one location but consumes at the other.

Given the characterization of efficient specific consumption, efficient storage can be characterized by a set of threshold levels of *z*. As described, above, there are only really four discrete choices for a given agent's storage: all at location 0; all at location 1; some at both locations; or no storage (self-storage). Note first that the last two of these options are independent of an agent's home location in terms of the lifetime utility they generate. Diversified deposits (some at each location) will be superior to self storage (no deposits with banks) if $u(x^*) - t \geq u(0) - h$. Of the other two options, the value generated by placing all deposits at location 0 is decreasing in *z*, while the value of placing all at location 1 is increasing in *z*. Define z_0, z_1, and z_{01} by the following three equalities:

$$fu(x^*) + (1-f)u(x^c) - c(1-f)x^c - tz_0 = \max[u(x^*) - t; u(0) - h];$$
$$fu(x^c) + (1-f)u(x^*) - c\,fx^c - t(1-z_1) = \max[u(x^*) - t; u(0) - h];$$
$$fu(x^*) + (1-f)u(x^c) - c(1-f)x^c - tz_{01} =. fu(x^c) + (1-f)u(x^*) - c\,fx^c - t(1-z_{01}).$$

Efficient deposit patterns, then, will depend on the cost parameters t, h and *c*, as well as on the parameters of the utility function *u* and the preference shock probability f. This paper will focus on two types of deposit patterns. A **two-segment** deposit pattern is one in which the relevant threshold is z_{01}, where all consumers with $z \leq z_{01}$ deposit only at 0, and all with $z \geq z_{01}$ deposit at 1.[7] A **three-segment** pattern is one with thresholds z_0, and $z_1 > z_0$; all agents with $z \leq z_0$ deposit only at 0, while those with $z \geq z_1$ deposit only at 1. Agents in the middle segment, (z_0, z_1) either diversify or self-store. Note that as t gets large the value of both specialized and diversified deposits decreases. Hence, the focus here will be on three-segment outcomes in which the middle segment receives no banking services. If the thresholds defined above are such that $z_0 < z_{01} < z_1$, then a tree-segment pattern is efficient, while a two segment pattern is efficient if this ordering of thresholds is reversed.

[7] The measure-zero set of agents at a threshold are indifferent.

3. Pricing of Services

The banks in this environment can extract earnings from the deposits placed with them by agents. As local monopolists, they can earn positive profits. They compete, however, in trying to attract deposits away from each other (and away from the self-storage option). One can imagine a wide range of pricing structures that might be employed. Any such structure amounts to a particular pricing game played by the banks.

Generally, one would assume that they would try to devise pricing schemes that allow them to extract the maximum profit. Typically, such schemes would involve as much price discrimination as is feasible. For the bank at location i, one can represent perfect price discrimination by a set of functions $x_i^j(z), y_i^j(z)$, for $i, j = 0,1,$ giving the second period specific consumption (x) and the third period generic consumption (y) of a consumer with deposits at i who consumes at j. These are functions of z, because an agent's original location will determine how much he can deposit at the bank. These consumption schedules are equivalent to nonlinear pricing schedules. In addition to setting these consumption schedules, banks might set prices that they charge each other for the provision of interlocation services. Specifically, bank i charges bank j a price q_i (in units of the generic good delivered in the final period) for each unit of location j good consumed by depositors from i. The game in which banks' strategy spaces consist of the space of functions $x_i^j(z), y_i^j(z)$ and the space of prices q_i will be referred to as the **perfect price discrimination game.**

Perfect price discrimination may not be feasible. For instance, a bank may not be able to discriminate among depositors on the basis of their home locations.[8] In such a case, banks may be limited to simpler pricing structures. One possible pricing structure involves prices only on transaction services, but different prices for intra- and interlocation payments. That is, each bank i might set three prices, p_i, q_{ai}, and q_{bi}. Here, p_i is the price charged by bank i to its own depositors for each unit of specific

[8] In the present environment, a depositor's home location is indicated by the amount of generic good he deposits. If the model were extended to allow heterogeneous endowments at given locations, then the amount of deposit would not reveal location of origin.

consumption at i. One could also think of this as the price for withdrawals prior to the final period. The other two prices represent the price of the two components of interlocation payment services. The first, q_{ai}, is the price that bank i charges its own depositors for each unit of specific good they consume at the other location, while q_{bi} is the price charged by bank i to depositors of the other location for each unit of specific good they consume at i. This last price can be viewed equivalently as a price charged by bank i to the other bank for allowing access to local payments. In this case, the price q_{ai}, should be viewed as the mark-up bank i sets over its own costs when its depositors consume abroad. When depositors from 0 consume at 1, for instance, bank 1 charges bank 0 q_{b1} per unit consumed, so that bank 0's marginal cost is q_{b1}.

This structure with three linear prices for three different types of transaction services is analogous to the pricing structures examined in the literature on telecommunication network competition. In that literature, the three prices are a price for within network calls, and prices for initiating and terminating inter-network calls. Papers by Laffont, Rey and Tirole and Economides, Lupomo and Woroch examine the effects of certain regulatory interventions when providers play this three-price game. One such rule is a reciprocity rule which requires some or all of the cross-network prices to be equated across providers. One might require, for instance, that $q_{b0} = q_{b1}$. In the cited literature, such a rule can result in a more efficient allocation by eliminating two sources of distortion. First, when providers set interlocation prices non-cooperatively, there is a classic "double marginalization" problem that arises when two firms with market power sell complementary goods; the services of both providers are necessary to complete an interlocation payment (or an internetwork call). Second, unrestrained competition gives sellers an incentive to compete for depositors (network membership) by raising the inter-network access price.

With the present model, one could perform an analogous exercise, including an examination of how results change as the model departs from symmetry. This model is fully symmetric when $f = \frac{1}{2}$. In this case, for instance, a reciprocity rule has the same effects as in the telecommunications literature. For $f \neq 0$, one can derive a generalized rule that would have the same beneficial effects. This generalized rule, however, becomes a complicated function of the model's parameters, and it is unlikely that an external regulator would have the information necessary to determine the correct rule.

Many of the insights that come from the three-price game outlined above can also be obtained from a game with an even simpler pricing structure. Notice first, that the three-price game involves prices on payment services but none on deposit services. In the context of the present model, this structure might seem odd or unreasonable. Consumers face an essentially discrete choice between depositing with bank 0 or bank 1. It seems natural to attach a price to that choice.[9] Also, the pricing of deposit services has historically been an important source of bank revenue, arguably more important than the direct pricing of payment services. While this fact is at least in part due to a tradition of legal restrictions on the payment of interest on deposits (which puts a lower bound on the price of deposit services), the technology for the joint provision of deposit and payment services may be important also, as it does in this model.

The simpler pricing structure to be considered, then, consists of two prices for each bank. First, each bank sets a price p_i for deposit services. This is a fixed price relative to the location and quantity of specific consumption. Each bank i also sets a price q_i which it charges for the other bank's depositors' consumption at location i. This price, in units of generic good per unit of specific good can be thought of either as being charged to the other bank or directly to the other bank's depositors.[10]

Given prices (p_0, q_0) and (p_1, q_1), one can determine the expected utility generated for a consumer at z from the various deposit options. First, define the functions $x(q)$ and $v(q)$ as follows:

$$
\begin{aligned}
x(q) &\equiv \arg\max[u(x) - (1+p)x], \\
v(q) &\equiv u(x(q)) - (1+q)x(q).
\end{aligned}
$$

The expected value of placing storage only at bank 0, then, is

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[9] Indeed, one might make the same observation about the telecommunications models, where consumers face a discrete choice of which network to join.

[10] It can be shown that if this price is charged, as an input price, to the other bank, and if the other bank is allowed to set a mark-up, the mark-up will optimally be chosen to be zero.

$V_0 = fv(0) + (1 - f)v(q_1) + w - tz - p_0.$

Similarly, the values of placing storage at bank 1 and at both banks are, respectively

$V_1 = fv(q_0) + (1 - f)v(0) + w - t(1 - z) - p_1,$

and

$V_{01} = v(0) + w - t - p_0 - p_1.$

Suppose that in the relevant ranges of prices p_0 and p_1, V_{01} is less than the value of self-storage, $u(0) + w - h \equiv V_h$. Then, the potential thresholds for determining deposit behavior are the points of indifference between pairs of options. The consumer who is indifferent between depositing only at zero and not depositing at either bank is described by z_0. That is, z_0 is the z for which $V_0 = V_h$. Similarly, at z_1, $V_1 = V_h$, while z_{01} is the point of indifference between depositing only at 0 and depositing only at 1; at z_{01}, $V_0 = V_1$. Normalizing $u(0)$ to 0, then, these thresholds are

$$z_0 = \frac{1}{t}\{fv(0) + (1 - f)v(q_1) + h - p_0\}$$

$$z_1 = 1 - \frac{1}{t}\{fv(q_0) + (1 - f)v(0) + h - p_1\}$$

$$z_{01} = \frac{1}{2} + \frac{1}{2t}\{fD(0,q_0) - (1 - f)D(0,q_1) + p_1 - p_0\},$$

where $D(q,q') \equiv v(q) - v(q')$.

Hence the market divides either into two segments, with all consumers $z < z_{01}$ depositing at 0 and those above at 1, or into three segments with all consumers between z_0 and z_1 being priced out of the market for bank services. The latter, three-segment market division will occur if $V_0 > V_1$ at z_0. This condition is equivalent to $z_0 < z_1$, which will be true if, at prices (p_0, q_0, p_1, q_1),

$$t > v(0) + fv(q_0) + (1 - f)v(q_1) + 2h - p_0 - p_1.$$

Hence, the three-segment outcome will tend to result, for given prices, when costs of depositing at banks are high relative to the cost of self-storage. Strategic interaction between the banks is quite different in the two- and three-segment cases. Consider first, the three-segment case. That is, consider a case in which parameters are such that equilibrium prices generate a three-segment market structure. To be precise, one should first define a price equilibrium. It is somewhat more convenient, however, to define and characterize a three-segment equilibrium (in solving for such an equilibrium, one would have to check that the above condition for the three-segment case is satisfied).

When there are three segments, divided at z_0 and z_1, the banks' profits can be written as:

$$\Pi_0 = z_0 p_0 + (1 - z_1) fx(q_0)(q_0 - c)$$
$$\Pi_1 = (1 - z_1) p_1 + z_0 (1 - f)x(q_1)(q_1 - c).$$

With these profit functions, a Nash equilibrium is a set of prices (p_0, q_0, p_1, q_1) such that for each i, (p_i, q_i) maximizes Π_i given the other bank's prices (p_j, q_j).

This pricing game results in a standard "double marginalization" problem. With three segments in the market, the marginal consumer is not choosing between depositing at 0 and depositing at 1. Rather, marginal consumers are choosing between depositing with one of the banks and not depositing at all. Hence, there is no direct competition between the banks. By rewriting the profit functions with the thresholds z_0 and z_1 expressed as functions of prices, one can see that that bank 0's choice of p_0 has no effect on its own profits from the sale of payment services to bank 1's depositors and no effect on bank 1's profits from the sale of deposit services. The choice of p_0 does, however, affect bank 1's sale of payment services to bank 0's customers, since an increase in p_0 reduces the number of depositors at 0. Similarly, bank 0's choice of q_0, its payment service price to bank 1's depositors, affects bank 1's profits from deposit services; an increase in q_0 increases the cost of depositing at 1, reducing the number of depositors at 1 but having no effect on depositors at 0.

The first order conditions for p_0 and q_0 can be written as (similar conditions hold for bank 1's prices):

$$fv(0) + (1-f)v(q_1) + h - p_0 = p_0$$
$$[fv(q_0) + (1-f)v(0) + h - p_1][1 - \frac{(q_0 - c)e}{1+q_0}] = fx(q_0)(q_0 - c),$$

where e is the price elasticity of the demand function x.[11]

These conditions, together with the analogous conditions for bank 1's prices, imply positive mark-ups in the equilibrium prices of payment services $(q_i > c)$. Unlike the usual case of a noncooperative pricing game among competing sellers of substitute goods, reducing a bank's payment services price q increases the rival's profits by increasing the rival's deposits. Indeed, calculating the prices that maximize the sum of the bank's profits would reveal that the optimal mark-up on payment services is zero $(q_i = c)$. Since such pricing eliminates a wedge between marginal cost and price, it has the potential of raising consumer welfare as well as profits, even though the collusive prices on deposit services (p_i) are greater than the corresponding noncooperative prices. This is, in fact, true for the three-segment case. To summarize:

Collusive choice of prices (p_0, q_0, p_1, q_1) results in higher bank profits and consumer welfare than does noncooperative pricing. Collusive deposit prices (p_i) are greater than noncooperative prices, and collusive payment services prices (q_i) are equal to marginal cost.

Of course collusive price agreements among sellers of related products may not be enforceable, especially in an environment where antitrust laws prohibit contracts in restraint of trade and where enforcement of such laws is imperfect. Finding it difficult or costly to determine which price fixing contracts are welfare enhancing and which are not,

[11] In general, the elasticity is a function of prices, a dependence that is suppressed in this notation.

the courts or administrative officials might reasonably opt to prohibit all such agreements.

In the telecommunications literature, some have suggested a regulatory rule imposing reciprocity in interconnection prices between networks as a way of dealing with the type of coordination problem outlined above. In the present model, a reciprocity rule would mean that one bank chooses a payment services price that must be used by both, while the banks continue to set their deposit prices noncooperatively. One can show that, in the three-segment case, a reciprocity rule results in exactly the collusive outcome if and only if the market is symmetric ($f = \frac{1}{2}$). Even when it does not implement the fully collusive prices, such a rule may still generally improve welfare, although this may depend on which bank chooses the "interconnection" price. The smaller bank (bank 0 if $f < \frac{1}{2}$) will have a tendency to put more weight on its profits from payment services and less on its profits from.

Matters are somewhat more complicated in the two-segment case. Here, the banks engage in direct competition for depositors. The payment services price becomes not just a source of revenues in its own right but also a tool by which a bank can increase the attractiveness of its own deposit services. By raising q_i , a bank makes it more costly for consumers to deposit their endowments with the other bank. Hence, in the two segment case firms have an even greater incentive to raise the mark-up of payment prices over marginal cost.

Some further Issues

One important point is that the role of the interlocation payment services price depends on the type of competition in which the banks engage. For instance, suppose banks play the "perfect price discrimination game" introduced above. This is a very aggressive form of competition, which amounts to dividing the market into a continuum of segments (one for each *z*) and engaging in direct (Bertrand) competition for each segment. Here allowing cooperation in interlocation payment pricing while maintaining competition in the pricing of deposit services can have a very different effect from above. Since an increase in q would reduce the cost of losing the competition for the deposits from a particular *z*, the intensity of such competition will tend to decline as q rises. That is, coordination on interconnection pricing can be a means to facilitate collusion among competing banks.

The model described above simply assumes the existence of only one bank at each location. One can (with certain limitations) examine the effects of introducing intra-location competition. One thing that is clear is that, with the technology assumed above, if there is a large number of banks (or potential banks) at each location (with identical technologies), then a competitive equilibrium will result in an efficient allocation. This issue, of course becomes more complicated if there are non-convexities in the technology for producing deposit and payment services. Since historical periods of deregulation of banking have often been associated with the elimination of certain protections from competition afforded to some banks, it should be useful to examine the effects of increasing competition with this type of model. This comment applies to both intra- and inter-location competition.

Introducing intra-location competition also allows one to consider a case that has some historical relevance in the U.S.. Much of the discussion about the check-clearing system before the founding of the Fed has centered on the behavior of small banks that were monopolists in small communities. One could model such a market structure by assuming that f is small and assuming that there is one bank at location 0 and many at location 1.

There are many possible extensions and variations of the model presented above. One worth noting involves the use of cash. Above, it was assumed that location-specific goods could only be purchased with claims on bank deposits. One could assume instead that agents could carry the generic good with them, at some cost. How would competition among banks affect the use of "cash," and how would changes in the cost of using cash affect the competition among banks? A simple extension of the present model could address such questions.

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