Imperfect Competition and the Pricing of Interbank Payment Services

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I n a modern economy, a large fraction of payments for goods and services involve the services of one or more banks. The provision of payment services is, in fact, one of the distinguishing characteristics of banks. A bank-intermediated payment instrument, such as a check, typically communicates instructions to the buyer's bank to make payment to the seller or the seller's bank. Often, then, we think of payment services as being bundled with the deposit services provided by banks, although this is not always the case. Credit cards, for instance, involve payments by the card-issuing bank, at which the cardholder need not hold deposits. Still, many payment services do arise naturally as byproducts of holding deposits with a bank, and some authors have recently begun to focus on this payments function in the theory of banking (McAndrews and Roberds 1999; Prescott and Weinberg 2000). Checks and debit cards are prominent examples of such payment services, but ATM service, which gives people remote access to cash from their deposit accounts, is also an example even though ATM transactions facilitate purchases with cash, not bank liabilities. Accordingly, the industrial organization of the payment services industry, and even the characteristics of the payment services provided, will generally depend on the organization of the banking industry itself.

One area in which the structure of the banking industry matters for the nature of payment services is that of interbank payments—payments in which

the services of more than one bank are required. In an economy where banking is dominated by a very few institutions, there may be a relatively large number of transactions in which the buyer and the seller have deposits with the same bank. In these cases, interbank payments are not necessary. On the other hand, if there are many banks and people frequently engage in transactions with customers of diverse institutions, then many payments will be interbank payments, requiring the services of both the buyer's and the seller's banks. In these cases each bank provides services to both its own and the other bank's depositors. The interbank payment services that one bank provides to another's depositors resemble the interconnection services that allow customers of one communication network to connect with those of a second network.[1]

In an environment in which banks compete for depositors, the terms on which they make interbank services available can be powerful strategic tools. By making interconnection very costly, a bank could dissuade potential depositors from placing deposits with competing banks. Such surcharges for interbank services create inefficiency by exceeding the resource costs of providing those services. Hence, there is potential tension between a bank's need to compete for depositors and its need to cooperate in interconnection in order to enhance the quality of its service. The implications of this tension depend on the market structure and the nature of competition in the banking industry. In a perfectly competitive, or perfectly "contestable" market, there is strong reason to expect efficient outcomes, even taking the network characteristics of payment services into account (Weinberg 1997). Competition, however, may be limited by regulatory or other features of the economic environment. For instance, in the United States, banking was historically segmented along geographic lines by an array of branching restrictions. In Japan, such segmentation was perhaps even more extensive, with different classes of institutions having specified sets of services or classes of customers they could serve (Ito 1992). In both of these countries, old barriers between market segments have eroded, increasing the opportunities for direct competition among a wider array of banks. Still, in many economies, limits to competition may remain.

In a segmented environment, the terms of interbank payment arrangements can have at most a limited effect on the competition among banks for depositors. The main concern in such an environment, then, would be the provision of the common resource represented by a comprehensive interbank network. Any conflicts of interest among banks would be mainly related to differences in the value that different banks placed on having access to such a network. For instance, in a banking system in which local clearing houses play an important role in payments within a region, a primary role of an interregional network is to connect the various clearing houses. Accordingly, banks that serve limited geographic areas will be most interested in the services of an

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[1] Laffont and Tirole (1998a,b) study interconnection pricing among rival telecommunication networks. McAndrews (1998) applies their model to an interbank setting.

interregional interbank network. In Japan, where there have traditionally been both regional and nationwide banks, the value of participating in an interbank, interregional network is likely smaller for the latter than for the former. A large, nationwide bank could use its own internal branch network to make connections among the various clearing houses. A bank with geographically limited operations, however, could benefit from having access to a national network. Indeed, in the 1940s, when the national clearing system was first established, regional banks took the greatest interest in its development, according to Tsurumi (1999). By way of contrast, the United States had no nationwide banks at the time of the founding of the Federal Reserve System, and the banks that lobbied for the Fed to create a national network for clearing interregional checks were primarily large banks in large cities (Lacker, Walker, and Weinberg 1999).

The pricing of interbank payment services typically falls into one of two broad categories: cooperative or independent. Independent pricing simply means that each bank sets the price for its own interbank services. Fees for clearing and settling checks were set independently in the period prior to the Fed's dominance of the check-clearing system. A contemporary example is the surcharge imposed by a bank for an ATM withdrawal by another bank's depositor. Cooperative price-setting usually takes the form of interbank prices set by a group or consortium of banks. Interchange fees in a payment card or ATM network are examples of this sort of cooperation.

It is generally accepted that cooperation among competing firms in the setting of prices can enable sellers to achieve higher prices and profits than they could obtain with independent pricing. This increase in profits comes at the expense of consumer welfare and economic efficiency. This principle is, of course, the basis for antitrust policy. On the other hand, when firms with some market power sell complementary goods, then cooperation can result in lower prices. When it bundles deposit and payment services, a bank is selling products that are both substitutes for and complements to the products of its rivals. This combination complicates the evaluation of cooperative price-setting.

This article explores the differences between cooperative and independent setting of interbank prices in alternative market environments. I focus specifically on the pricing of interbank payment services when deposit markets are segmented, as compared to when banks compete directly for deposits. An important qualification of this discussion is that it takes the structure of the banking market, given by the set of potential market participants, as fixed. That is, I do not consider the effects of free entry or potential competition. In essence, then, the article explores how changes in the degree of imperfect competition affect the comparison of cooperative and independent pricing.

I address the question of how interbank pricing might respond to a change in the competitive environment in which banks operate, first in fairly general

terms and then in the context of a simple model of bank competition and inter-connection. The main insight drawn from this discussion can be summarized as follows. Cooperation in the setting of interbank prices typically leads to lower interbank prices and greater consumer welfare and profits when deposit markets are segmented. On the other hand, when banks compete directly for deposits, cooperation in setting interbank prices can have the effect of damp-ening competition in the deposit market, given a fixed set of competitors. This could result in higher interbank prices and reduced consumer welfare.

1.   THE ELEMENTS OF AN INTERBANK PRICING GAME

I begin by describing a model of price competition between two banks facing demands for deposits and interbank payment services. The demand structure specified below can be derived from a more detailed economic environment involving the need for agents to engage sometimes in storage and consumption activities at physically distinct locations.[2] The same general structure would arise in any economic environment in which a diverse set of buyers and sell-ers of goods and services acquire both deposit and transaction services from potentially competing banks. While models adapted from the telecommuni-cations literature can fit into this framework, the general structure allows for some additional important features. Specifically, and as will be shown by the example in Section 2, this framework can accommodate differences between competing banks. This is a useful feature since many discussions of compe-tition among banks focus on the relative competitive positions of large and small banks.

Demand Functions and Prices

Consider a market in which two banks raise deposits that can be used to make payments in the purchase of goods. To be concrete, focus on the market for household deposits and the payment services provided by banks to house-holds for making purchases from firms. Also, in the interest of simplicity, suppose that firms are exogenously assigned to banks, some with each bank. A consumer selects a bank at which to deposit; the consumer's choice will affect the set of firms to which it can costlessly make payments. If we assume that consumers are randomly matched with firms for the purpose of making purchases, then each consumer faces some chance that he or she will need to make a purchase from a firm that does not use his or her bank. Completion of such a transaction will require an interbank transaction, in which the firm's bank credits the firm's account and collects funds from the consumer's bank.

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[2] See Weinberg (2000).

In order to examine interbank pricing and competition, the description of this market structure must specify demand functions for bank services. Labeling the banks 0 and 1, let z_i represent the number of depositors attracted by bank i, and let x_i represent the number of interbank transactions entered into by a customer of bank i.[3] These quantities will respond to the prices set by the two banks. Assume that each bank sets two prices, one price for deposit services that also covers all same-bank payments and another price for each interbank transaction. Let bank i's price for deposit services be denoted by p_i and let its price for an interbank transaction be given by q_i. More precisely, bank i collects p_i from each consumer who places deposits with it and collects q_i from the other bank's depositors for each purchase they make from firms that use bank i. A more general pricing structure would allow a bank to charge transaction fees to its own depositors as well as to its rival's depositors. The simpler structure specified here is sufficient to capture the combination of complementarity and substitutability that banks face when they make pricing decisions.[4]

The actions of the banks and their customers proceed through three stages. First, banks announce their prices. Next, depositors choose with which bank to place their funds. Finally, depositors make purchases. If a depositor wishes to make a purchase from a seller that is associated with a different bank, then the depositor needs the services of the seller's bank to complete the purchase. The depositor values both the consumption of goods purchased and the deposits left over after buying goods and paying bank fees.

In general, one can assume that both the number of depositors a bank attracts and the number of interbank transactions it services will be functions of the full set of prices, (p_0, p_1, q_0, q_1). In choosing a bank, a depositor will weigh the value of depositing at bank 0 against the value of depositing at bank 1 and against the value of not using banking services at all. The value to a depositor of placing deposits with bank i depends on (p_i, q_j). The demand for deposits at bank 1 (z_1) is decreasing in p_1 and q_0 and either independent of or increasing in p_0 and q_1.[5] An increase in q_0 causes this demand to fall because q_0 is the price paid by bank 1's depositors when they must make a purchase from a customer of bank 0. The dependence of z_1 on p_0 and q_1 is determined by the degree to which the two banks' markets for deposits are segmented. Segmentation of the markets could be the result of fundamental demand characteristics, such as the degree to which consumers find the deposit services of the two banks to be good substitutes. Market segmentation could

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[3] This specification treats z_i as both the number of depositors and the value of deposits attracted. Hence, each consumer is assumed to have one unit of funds available for deposit.

[4] The interaction between interbank pricing and the pricing of services to one's own depositors under more general pricing structures is qualitatively similar to that presented in this article.

[5] The treatment of the demand facing bank 0 is symmetric to that for bank 1.

also arise from artificial barriers to competition, such as legal rules that limit the set of consumers a particular bank (or type of bank) may serve.

If there are no consumers who could reasonably choose to bank at either bank, then the markets are fully segmented and p_0 and q_1 will have no effect on z_1. If, on the other hand, the two banks compete directly for at least some customers, then z_1 is increasing in p_0 and q_1, which determine the cost of depositing with bank 0.

For a given depositor at bank 1, the demand for interbank transactions depends only on q_0, the price charged for such transactions. This is due to the assumed timing of the depositor's decisions. When the depositor makes a consumption decision (chooses x), deposits have already been placed with a bank. Hence, the depositor's only remaining decision is to weigh the marginal utility of consumption against its price. Here, the price of consumption is either zero (if the depositor is buying from a seller who uses the same bank as the depositor) or q_j for an interbank purchase (from a seller that uses the other bank [bank j]). The total quantity of interbank transactions on which bank 0 collects q_0 is $z_1 x_1$. The banks' profits can be written as $\Pi_1 = z_1 p_1 + z_0 x_0 (q_1 - c)$ and $\Pi_0 = z_0 p_0 + z_1 x_1 (q_0 - c)$, where c is the cost to the bank of processing and collecting on an interbank payment.[6]

Pricing Behavior

The banks set prices for payment and deposit services to maximize their profits, each taking the other's prices as given. Consider, for instance, bank 1's profit maximization problem. Its first order conditions are[7]

$$\frac{\partial \Pi_1}{\partial p_1} = z_1 + \frac{\partial z_1}{\partial p_1} p_1 + \frac{\partial z_0}{\partial p_1} x_0 (q_1 - c) = 0; \text{ and}$$

$$\frac{\partial \Pi_1}{\partial q_1} = z_0 x_0 + \frac{\partial z_1}{\partial q_1} p_1 + (\frac{\partial z_0}{\partial q_1} x_0 + \frac{\partial x_0}{\partial q_1} z_0)(q_1 - c) = 0.$$

These two equations can be rewritten as

$$1 + \eta_{p_1}^1 + \eta_{p_1}^0 \frac{z_0 x_0 (q_1 - c)}{p_1 z_1} = 0; \text{ and}$$

$$1 + \mu_1 (\eta_{q_1}^0 + \epsilon_{q_1}^0) + \eta_{q_1}^1 \frac{z_1 p_1}{z_0 x_0 q_1} = 0,$$

where η_j^i is the elasticity of z_i (demand for deposits at bank i) with respect to price j; ϵ_j^i is the elasticity x_i (demand for interbank payment services from

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[6] The profit functions reflect the assumption (for simplicity) that variable costs of deposit services are zero.

[7] Similar conditions hold for bank 0.

bank i) with respect to price j; and $\mu_i = \frac{q_i - c}{q_i}$ is the percent mark-up of bank i's interbank price over marginal cost.[8]

The conditions above capture the typical result that a profit-maximizing price is inversely related to the relevant (own-price) demand elasticities. The first condition indicates that, in addition to the price elasticity of its own deposit demand, a bank's choice of a price for its deposit services also depends on the cross-price elasticity of the other bank's deposit demand. This dependence arises because the bank earns profits by providing interbank payment services to its rival's depositors. Since deposits at the two banks are substitute services, own-price and cross-price elasticities have opposite signs; raising bank 1's own deposit price increases bank 0's deposits, thereby increasing bank 1's interbank services. The effect is to amplify a bank's desire to raise deposit prices, other things being equal. The magnitude of this effect depends on the relative contributions that payment services and deposit services make to a bank's profits.

A similar interpretation can be given to the second condition above. When setting its price on payment services, a bank considers both the direct effect of the price on its own sale of payment services and the indirect effect on its sale of deposit services. The latter results because bank 1's payment services are complementary to bank 0's deposit services, which are substitutes for bank 1's own deposit services. Again, the strength of the indirect effect depends on the relative contributions the two services make to a bank's overall business.

Segmented Markets

The joint solution of the two banks' problems and the nature of the interaction between prices of interbank payment services and prices of basic deposit services depend on the nature of competition between the banks. In part, the nature of interbank rivalry is determined by the structure of the banks' external environment. In particular, the degree of integration or segmentation of markets determines whether the banks come into face-to-face competition with each other. This characteristic of the markets is captured by the demand functions, and the degree of segmentation is represented by the values of the elasticities $\eta^i_{p_j}$, for $i \neq j$, and $\eta^i_{q_i}$. These elasticities reflect the responsiveness of a bank's deposits to the other bank's deposit price and to its own interbank payment price. Recall that a bank's interbank price is paid by the other bank's depositors. Hence, q_1 will affect z_1 only if banks 1 and 0 compete directly for customers. When the deposit markets are segmented, $\eta^0_{p_1} = \eta^1_{p_0} = \eta^0_{q_0} = \eta^1_{q_1} = 0$.

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[8] It is common to express own-price elasticities as absolute values. Here, $\eta^i_{p_i}$ and $\epsilon^i_{q_i}$ are defined as negative numbers. This seems convenient, as own-price elasticities are combined in some expressions with cross-price elasticities, which may be negative or positive.

When markets are segmented, then the first order conditions above reduce to

$$\frac{\partial \Pi_1}{\partial p_1} = z_1 + \frac{\partial z_1}{\partial p_1} p_1 = 0; \text{ and}$$

$$\frac{\partial \Pi_1}{\partial q_1} = z_0 x_0 + (\frac{\partial z_0}{\partial q_1} x_0 + \frac{\partial x_0}{\partial q_1} z_0)(q_1 - c) = 0.$$

Or, in terms of elasticities,

$$1 + \eta^1_{p_1} = 0; \text{ and}$$

$$1 + \mu_1(\eta^0_{q_1} + \epsilon^0_{q_1}) = 0.$$

Note that even when markets are segmented, one bank's pricing is not entirely independent of the other bank's prices. Each bank's deposit demand depends on its own deposit price and the other bank's payment service (interconnection) price. That is, z_1 depends on p_1 and q_0. Still, under segmented markets, a bank's pricing of its own deposit services does not interact directly with its pricing of interbank payment services.

In the case of segmented markets, one bank's deposit services are complementary to the other bank's interbank payment services. For instance, an increase in q_0, bank 0's payment service price, reduces the value to potential customers of placing deposits at bank 1. The price increase will generally result in lower demand for bank 1 deposits and lower profit-maximizing value of p_1, bank 1's deposit price. At the same time, an increase in p_0 reduces the total value of deposits bank 0 is able to attract and correspondingly reduces the volume of interbank transactions on which bank 1 can extract a fee. This reduction in demand results in a lower optimal choice of q_1.

When two sellers set the prices of complementary goods noncooperatively, the outcome is often characterized as a problem of "double-marginalization." In effect, the two goods can be thought of as a single service with two distinct components. If both components were sold by a single seller with market power, that seller would recognize the effect of each component's price on the sale of both components. This interdependence limits the seller's interest in raising prices. When the components are sold separately by different firms, each seller is interested in only its own profits and ignores the effects of its price on the other seller's sales. As a result, the distortion due to the deviation of price from marginal cost is compounded by the independent profit-maximizing behavior of two sellers with market power. This compound distortion comes at the cost of both combined seller profits and consumer welfare. Hence, the independent pricing of complementary goods resembles decisionmaking in settings with externalities. Each bank ignores the effect of its interbank price on the sales of the other bank, and their noncooperation leads to a loss of efficiency. Unlike losses occurring in the case of a true externality, however,

this loss occurs here only because competition is imperfect and each bank exercises some market power. If for instance there were additional banks whose deposit and payment services were perfect substitutes for those of bank 0, then both p_0 and q_0 would be competed down to marginal cost. The same would be true for bank 1 in the presence of additional competition.

If instead of setting all prices noncooperatively, banks set their prices for interbank services through negotiation, they can raise their combined profits by setting interbank prices (q_0 and q_1) lower than their noncooperative levels. This process is formalized by assuming that q_0 and q_1 are set to maximize joint profits, conditional on the noncooperative determination of p_0 and p_1. The process represents a mixed form of interaction between sellers in which they collude on interbank prices while they compete in the pricing of deposit services. For many specifications of the demand structure, the optimal negotiated choice for interbank prices is to set them equal to marginal cost. This choice eliminates the double marginalization problem, allowing banks to earn their rents from the markup on deposit services. When deposit markets are segmented, cooperation in setting the interbank prices is equivalent to full cooperation in setting all prices, for banks are local monopolists in their deposit market segments.

To see the effects of cooperating in interbank price-setting in segmented markets, consider the first order condition for choosing q_1 to maximize joint profits ($\Pi_0 + \Pi_1$). In terms of elasticities,

$$1 + \eta_{q_1}^0 \frac{p_0}{(q_1 - c)x_0} + \mu_1(\eta_{q_1}^0 + \epsilon_{q_1}^0) = 0.$$

This cooperative condition has one more term than the corresponding noncooperative condition: $\eta_{q_1}^0 \frac{p_0}{(q_1-c)x_0}$. The extra term reflects the effect of bank 1's choice of interbank price q_1 on bank 0's earnings from deposits priced at p_0. The effect of the added term is to reduce the choice of q_1, other things being equal.

In segmented markets, the mechanism for jointly determining interbank prices is not a matter of great importance. Suppose the jointly optimal interbank prices are $q_0 = q_1 = q$. A relatively simple mechanism that will achieve this result is to delegate the choice of a common interbank price to one of the banks. That is, impose symmetry in interbank prices and let the price level be chosen by either of the banks. Suppose this authority is granted to bank 0. Its choice of q_0 does not affect its own profits, but q_1 does. If the demands facing the two banks are symmetric, then bank 0's optimal choice is to set $q_0 = \hat{q}$. Bank 1 would make the same choice if it were given the authority to set the q's. Hence, with segmented markets and symmetric demands, delegated setting of reciprocal interbank prices achieves the same interbank price as would be set under joint profit maximization, subject to noncooperative choices of deposit prices. This mechanism, then, results in lower interbank prices than would be

chosen independently by the two banks. There are some cases in which this mechanism results in interbank prices that are equal to marginal cost.

When markets are not segmented, the interaction between deposit prices and payment service prices is more complicated. In this case, the interbank prices (q_0, q_1) are a strategic tool in competition for market share. In addition to raising revenue for bank 0, q_0 imposes a cost on bank 1's depositors that, other things being equal, may induce some consumers to deposit at bank 0 instead. To the extent that bank 0 is able to extract price-cost margins from deposit customers that are large relative to markups on payment services, the bank may find it profitable to use a high interbank price to help attract deposits. It is also not the case that cooperation in setting interbank prices will necessarily improve consumer welfare. That cooperation has ambiguous consequences is one of the messages of the literature on interconnection pricing in telecommunications networks. The interbank price could facilitate collusion in deposit pricing by making depositors less likely to switch banks.

It may be reasonable to think of an increase in competition (or more precisely in the potential competitiveness of the market environment) as being captured by a move from segmented markets to a single integrated market. Such a shift could have many causes. Changes in the regulatory or legal environment could bring banks that had previously enjoyed protected market segments into direct competition. Improvements in technology can make it possible for banks to serve expanding sets of customers. For instance, consumer banking may traditionally have been a local business, with people choosing banks based on their proximity to home or place of business. Technological advances allow consumers to make banking choices that are less dependent on location.

If we think of increasing competition as a shift from segmented to integrated markets, then it becomes clear that the role of interbank prices can change in a more competitive environment. With less competition (segmented markets) the interbank price serves mainly as a potential source for double marginalization. Accordingly, cooperation in setting the interbank price is largely beneficial from the point of view of consumer welfare. As markets become more competitive (integrated), the interbank price plays a more complicated strategic role.

Of course, the degree of competition between two banks also depends in part on the behavior of the banks themselves. Is their pricing competitive, in the sense that price determination can be modeled as the Nash equilibrium of a noncooperative game? Or is there some amount of cooperation between the banks in their price-setting behavior? This aspect of the degree of competition is more difficult to tie directly to the demand and cost fundamentals of the market. Rather, the ability of banks to collude depends on such factors as the legal environment. In a setting with strict antitrust enforcement, it will be difficult for sellers of a product or service to engage in explicit or open price

collusion. Even so, tacit collusion may be possible, in the form of cooperation supported by implicit threats to engage in a price war should any seller cheat on the collusive agreement.[9] The feasibility of such collusion depends on factors like sellers' ability to monitor each other's behavior.

The foregoing discussion has assumed that banks behave as Nash price-setters. Under that assumption, the degree of competition is determined by the demand characteristics, as discussed above.

Suppose that banks do collude in the setting of all prices. In that case, prices are set to maximize joint profits, $\Pi_0 + \Pi_1$. In this case, the first order conditions for (for instance) (p_1, q_1) are

$$\frac{\partial(\Pi_0 + \Pi_1)}{\partial p_1} = z_1 + \frac{\partial z_1}{\partial p_1}[p_1 + x_1(q_0 - c)] + \frac{\partial z_0}{\partial p_1}[p_0 + x_0(q_1 - c)] = 0;$$

and

$$\begin{aligned}\frac{\partial(\Pi_0 + \Pi_1)}{\partial q_1} &= \frac{\partial z_1}{\partial q_1}[p_1 + x_1(q_0 - c)] + \frac{\partial z_0}{\partial q_1}[p_0 + x_0(q_1 - c)] \\ &\quad + z_0[\frac{\partial x_0}{\partial q_1}(q_1 - c) + x_0] \\ &= 0.\end{aligned}$$

As with other conditions stated above, these last two can be expressed in terms of demand elasticities as

$$1 + \eta_{p_1}^1[1 + \frac{x_1(q_0 - c)}{p_1}] + \eta_{p_1}^0 \frac{p_0 z_0 + z_0 x_0(q_1 - c)}{p_1 z_1} = 0; \text{ and}$$

$$1 + \mu_1(\eta_{q_1}^0 + \epsilon_{q_1}^0) + \eta_{q_1}^0 \frac{p_0}{x_0 q_1} + \eta_{q_1}^1 \frac{z_1 p_1 + z_1 x_1(q_0 - c)}{z_0 x_0 q_1} = 0.$$

For any given configuration of demand, cooperative price-setting tends to result in higher deposit prices (p's) and lower payment services prices (q's) than does noncooperative pricing. Payment services provide interconnection between banks, allowing one bank's customers to use another bank's facilities. The prices charged for these services, then, are prices charged to another bank's depositors. When prices are set noncooperatively, a bank ignores the effect that raising the payment services price has on its rival's demand and profits. Taking this effect into account initiates cooperation, which results in a moderation of the desire to raise this price. Hence, when banks collude in the setting of deposit prices, either explicitly or implicitly, the role of the interbank price resembles its role in segmented markets.

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[9] Green and Porter (1984).

One additional issue regarding tacit (or implicit) collusion involves the role that interbank prices might play in coordinating collusive pricing. Banks must monitor implicit agreements not to engage in aggressive competition in deposit prices, and the monitoring of a rival bank's deposit arrangements with its customers may be difficult compared to monitoring prices of interbank payment services. If, for instance, bank 1 charges a fee to bank 0's depositor, that fee is typically collected through bank 0 (that is, through the interbank clearing and settlement system). Hence, bank 0 will directly observe the fees its customers face from bank 1. The ease of monitoring interbank prices could give them a role to play in the enforcement of broader agreements among banks.

2.   AN EXAMPLE

The strategic interaction among banks (or firms in general) in setting interconnection prices can be illustrated by an example in which consumers are assumed to have "home" locations on the "Hotelling" line (Hotelling 1929). That is, each consumer's location is given by a point in the unit interval, $z \in [0, 1]$. There are two banks, located at either end point of the interval. The cost to a consumer located at z of depositing funds at bank 0 is τz, and the cost of depositing at bank 1 is $\tau(1 - z)$. A consumer receives utility W from deposit services and U from payment services. One could interpret W as the balances deposited with the bank. If the consumer is able to use his or her deposit balances to make a purchase of goods from a store, then U will represent the net benefit that the consumer receives from such a transaction. Hence, a "payment service" here might be a transfer of funds from the consumer's account to the store's account. Alternatively, a payment service might be the withdrawal of cash at a cash dispensing terminal close to the place where the consumer will make a purchase. In either case, the net value received by the consumer will be $W + U$ minus fees paid to banks. A consumer also has the option of not depositing funds in a bank. For simplicity, assume that by not using bank services the consumer limits his or her ability to make certain purchases. Specifying the value to the consumer of not depositing funds with a bank as W captures this assumption.

Consumers face uncertainty about where they will want to consume final goods. This uncertainty translates into uncertainty regarding the bank from which the consumer will need deposit services. With probability ϕ, a consumer needs the services of bank 0. This might be interpreted as a consumer's desire to transfer funds to a merchant who banks with bank 0 or as a consumer's need to withdraw funds from a machine owned by bank 0. With probability $(1 - \phi)$, the consumer needs the payment services of bank 1.

Bank i bundles deposit services and payment services to its own depositors under a single price p_i and charges q_i for payment services provided to

the other bank's depositors. The net benefits that a consumer derives from depositing with either bank are given by

$$V_0 = W + U - p_0 - (1 - \phi)q_1 - \tau z; \text{ and}$$
$$V_1 = W + U - p_1 - \phi q_0 - \tau(1 - z).$$

If, for a given z, the greater of V_0 and V_1 is greater than W, then the consumer deposits with whichever offers the greater value. Let z_i denote the consumer for whom $V_i = W$. Then, the case of segmented markets, as discussed above, is the case in which $z_0 < z_1$. In this case, there is a set of consumers (those between z_0 and z_1) who do not use banking services. Consumers between 0 and z_0 deposit at bank 0, while those between z_1 and 1 deposit at bank 1. Given this specification of demand, banks' profit functions (when markets are segmented) can be written as[10]

$$\Pi_0 = z_0 p_0 + \phi(1 - z_1)q_0; \text{ and}$$
$$\Pi_1 = (1 - z_1)p_1 + (1 - \phi)z_0 q_1.$$

This specification of segmented markets involves a "gap" in the market for banking services that represents consumers who choose not to deposit their funds in the banking system. While there are, in fact, such "unbanked" consumers in many economies (close to 10 percent of all households in the United States), one need not take this specification literally. The choice of interbank prices would be similar in any setting in which a bank's choice of q had no effect on its own deposits. This would be true, for instance, if deposit market segmentation were established by legal or regulatory rules.

Noncooperative price-setting by banks in this example leads to the following Nash equilibrium prices: $p_0 = p_1 = \frac{U}{3}$; $q_0 = \min[\frac{U}{3\phi}, U]$; $q_1 = \min[\frac{U}{3(1-\phi)}, U]$. The reason interbank prices must be less than U is that consumers can always choose not to use interbank services, forgoing the utility U. With these prices, the market division is given by $z_0 = (1 - z_1) = \frac{U}{3\tau}$, so that the two banks have equal market shares.[11]

When the noncooperative equilibrium has this segmented markets characteristic, cooperation in the setting of interconnection prices is equivalent to full cooperation in all prices. This is true because with segmented markets, each bank is a local monopolist in its segment of the deposit services market. Still, cooperation results in a preferred outcome for both banks and consumers.

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[10] For simplicity, this example assumes that the marginal costs of both deposit and payment services are zero. Assuming positive marginal costs would not alter the nature of the strategic interaction among banks. However, assuming a higher marginal cost for interbank payment services than for same bank services would add an important dimension to the efficiency properties of equilibrium allocations.

[11] This characterization of the equilibrium assumes that $\tau > \frac{2}{3}U$.

Under this pricing scenario, interbank prices (q_0, q_1) are set equal to marginal cost $(q_0 = q_1 = 0)$, and deposit prices are $p_0 = p_1 = \frac{U}{2}$. Hence, deposit prices go up while interbank charges go down. The net effect on consumer welfare is positive, as is demonstrated by the fact that more consumers choose to use bank services under this pricing scenario than under noncooperative pricing. With the cooperative prices, market shares are $z_0 = z_1 = \frac{U}{2\tau}$.

Whether the equilibrium features segmented or integrated markets depends, of course, on the parameters of the model. In particular, U gives the value of having access to payment services, and τ gives the consumer's marginal cost of using bank services. As τ gets smaller or U gets bigger, more consumers will seek to use bank services, and eventually the marginal consumer's decision will be between banks rather than whether to deposit at all. When the market becomes integrated in this way, banks' shares of the market are determined by the point (z), at which a consumer is indifferent between the two banks $(V_0 = V_1 > W)$. Denoting this point by $\hat{z}$, we have

$$\hat{z} = \frac{1}{2} + \frac{1}{\tau}[(p_1 + \phi q_0) - (p_0 + (1 - \phi)q_1)],$$

and banks' profit functions are

$$\begin{aligned}
\Pi_0 &= \hat{z}p_0 + \phi(1 - \hat{z})q_0, \\
\Pi_1 &= (1 - \hat{z})p_1 + (1 - \phi)\hat{z}q_0.
\end{aligned}$$

Under these conditions, banks have a heightened incentive to raise the interconnection price compared to the case of segmented markets. With segmented markets, q_0 has no effect on bank 0's sale of deposit services to its own customers. Here, raising q_0 raises the cost to consumers of depositing with bank 1. When the market is integrated, any loss of depositors by bank 1 is matched by a gain at bank 0. Indeed, in this example the profit-maximizing choice for q_0 and q_1 is $q_0 = q_1 = U$. Deposit prices are then $p_0 = 2\tau + \phi U$ and $p_0 = 2\tau + (1 - \phi)U$.

With an integrated market, it is no longer true that banks can raise their combined profits by agreeing to lower interconnection prices. In particular, each bank's profits are lower if interconnection prices are set at marginal cost. That is, cooperation on interbank prices alone does not tend to drive those prices down to marginal cost. On the other hand, if banks collude on both interbank and deposit prices, then joint profits are maximized by setting interbank prices equal to zero.[12]

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[12] Actually, in this example, where consumers end up using either zero or one unit of interbank services, the joint profit maximizing solution determines only the sums $p_0 + (1 - \phi)q_1$ and $p_1 + \phi q_0$. In an extended example, with downward sloping demand for interbank services, joint maximization would drive the interbank prices to marginal cost.

3.   CONCLUSION

In many economies, the business of banking is undergoing profound changes. Boundaries between markets, both geographically and in terms of product lines, are being removed by regulatory changes and technological advances. These changes present challenges to traditional ways of handling interbank clearing and settlement arrangements. If the terms for interbank transactions are established by industry-based, collaborative organizations, how will such arrangements respond to the entry of new market participants? This article has suggested that increasing (though still imperfect) competition creates a complicated set of incentives for banks with regard to the terms for interbank payment services. Neither competition nor cooperation in setting these prices is guaranteed to always yield desirable results from the point of view of consumer welfare. This does not necessarily imply the need for a regulatory mechanism in determining interbank prices. The development of such a mechanism, managed by a governmental authority, is subject to its own drawbacks—including, for instance, the difficulty faced by a regulator in obtaining the information necessary to set optimal interconnection prices. Rather than direct regulation, however, there may be call to carefully monitor of industry practices in interconnection pricing. Such monitoring was perhaps less important in an environment with less direct competition among banks. It is somewhat ironic, then, that increasing competition may actually increase concerns for the competitive impact of interbank payment services pricing.

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