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A MODEL OF CHECK EXCHANGE

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A MODEL OF CHECK EXCHANGE

Abstract

We construct and simulate a model of check exchange to examine the incentives a bank (or a bank clearinghouse) has to engage in practices that limit access to its payment facilities, in particular delaying the availability of check payment. The potentially disadvantaged bank has the option of directly presenting checks to the first bank. We find that if the retail banking market is highly competitive, the first bank will not engage in such practices, but if the retail banking market is imperfectly competitive, it will find it advantageous to restrict access to its facilities. Lower costs of direct presentment can reduce (but not eliminate) the range over which these practices are employed. The practice of delayed presentment can either reduce or increase welfare, again depending on the degree of competition in the market. The model suggests that, were the Federal Reserve System to exit the business of check processing, practices such as delayed presentment would be more prevalent.

I. Introduction

Check exchange involves banks' collecting the checks of other banks and presenting them to the bank on which they were drawn, and receiving checks presented to them and paying for the valid checks. Underlying this activity is some agreement to exchange the checks, and this agreement specifies acceptable forms of payment, times and places of presentment, and so on. Clearinghouses represent such agreements by groups of banks. Alternatively, if banks cannot agree to terms of check exchange, each has the right to directly present checks to the other.

Nonetheless, check exchange represents an interconnected system of exchange in which a depositor can pay some merchant for a good by check and the merchant can deposit that check in its bank, despite the fact that the merchant and the depositor have different banks. Interconnected systems of exchange create unique incentives and behavior by the parties to the exchanges: each bank is both a competitor and a supplier of intermediate goods to its rivals. Credit card and automated teller machine systems, telephone systems, railroad interchanges, all represent systems in which a transaction originated by one firm in the system may be completed by another. Usually, centralized organizations or government regulation govern the interchange created by the interconnected system.

Check exchange in the U.S. is governed by law and regulation, and is also influenced by the presence of the Federal Reserve System as a major processor of checks. One major difference, for example, between the system of check exchange and that of other interconnected systems is the institution of par presentment. In most of the interconnected systems previously mentioned, a price is paid by one firm in the transaction to the other firm in the transaction, for the origination or completion of the transaction. Checks operate with no price being paid for the collection or payment for checks: this is known as par presentment.[1] Par presentment is now a well-established fact of U.S. check exchange, but earlier in this century, many banks charged "exchange" fees for the payment of checks drawn on accounts held by the bank.

The exchange of checks is subject to significant economies in sorting, transporting, and exchanging items multilaterally. By netting offsetting check payments, banks can significantly reduce their costs of check collection and payment. However, if a bank can impose costs on its rivals, it may advantage itself in the retail banking market.[2] Hence the possibility exists that a bank or banks that control access to a clearinghouse (or to their own facilities) would limit access to rivals to gain advantages in the downstream market.

Access can be limited by offering lower quality service or higher priced service to the other bank. Economides et al. (1996b) examine the incentives for a dominant firm in an interconnected system to charge its rival high prices to interconnect with it. In check exchange, however, par presentment limits the ability of a bank or clearinghouse to charge its rivals high prices.

We investigate the possibility that a bank would delay, by a day, payment for checks drawn on its accounts. Currently, the Federal Reserve System establishes "availability zones," a

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[1]In some telephone systems, a similar system of interchange, called "bill and keep," is used. The name suggests that the network that originates the call bills its customer and keeps all the revenue (not sharing it with the network that completes the call). See Economides, Lopomo, and Woroch, (1996a), for a discussion. Fees for processing (sorting and transporting) of checks are charged under par presentment, but "exchange charges" or "discounts" from the face value of the checks are not.

[2]Raising rivals' costs is a well known strategy; see Salop and Scheffman (1983) for a discussion.

system that determines the times by which checks are paid. If the Fed were to exit the check processing business, a clearinghouse or dominant correspondent bank might have the opportunity and desire to delay payment to other banks relative to the current timetable.

However, other banks have the right to directly present checks (and receive same-day availability) to the bank that is attempting to delay availability. Direct presentment is costly to banks--both for the collecting and the paying bank--relative to (symmetric) clearinghouse agreements. The extra cost is incurred by the paying bank in additional (bank-specific) sorting and transportation expense, and for the paying bank in additional (time-critical) account reconciliation and higher-cost payment methods, such as Fedwire. Hence, it is an open question of whether the tactic of delaying availability is a profitable one.

We construct and simulate a model of check exchange to examine the incentives a bank (or a bank clearinghouse) has to delay the availability of check payment. The model is similar to the one introduced by Laffont, Rey, and Tirole (1996). The potentially disadvantaged bank has the option of directly presenting checks to the first bank.

Our model necessarily abstracts from many realistic features of the check exchange market. Our aim is to isolate those features of the market that are particular to check exchange, without in any way “loading the dice” to convey excessive strategic advantage to one firm.

To this end, the firms are equal in size and technology, have similar location advantages, and enjoy the same costs of check processing. All check transportation and sorting are assumed to be done at equal marginal and average costs for the two firms. Hence, there are no advantages granted to either firm by virtue of its rival being small or remote. Furthermore, there are two banks in the model. As a result, there is no multilateral benefit to check exchange in the model.

One bank does not control access to a multilateral organization without which the other is at an enormous disadvantage.

The one advantage that one bank, called bank 1, is granted in the model is to decide whether it wishes to impose delayed availability on bank 2. The advantage is purely strategic, in the sense that it is a first mover advantage, and not an economic advantage. Bank 2 can respond by directly presenting checks to bank 1.

How are we to interpret the first mover advantage? One interpretation of the two banks in the model is that bank 1 is a branch of a national correspondent bank, while bank 2 is a community bank, equal in size to bank 1. Alternatively, bank 1 can be more loosely interpreted as a clearinghouse and bank 2 as the set of banks not in the clearinghouse, and the clearinghouse determines the availability zones (in this interpretation, the clearinghouse gains no superior technology from multilateral clearing and settlement relative to bank 2). Bank 1, by virtue of its being the correspondent, or the clearinghouse, establishes the availability zones in the market, subject to the threat of direct presentment by bank 2.

Another important feature of the model is the nature of the competition for retail customers. The banks are assumed to be located in different spots. Bank 1 is at point 0 on the interval [0, 1], while bank 2 is at point 1. The consumers in the model are uniformly distributed across the interval. Each consumer would prefer to have a bank right where she lives but, in general, must suffer a travel cost, t per unit distance, to a bank. Naturally, if the banks charge equal prices, all consumers located to the left of .5 will travel to bank 1, and those to the right will travel to 1 to do their banking. However, if bank 1 lowers its price, it will attract some consumers to the right of .5. If the travel cost is zero, this is a model of perfect substitutability of the banks, and prices are competitive. Hence we can interpret t as an index of competition: the lower t is, the less pricing power the banks have over nearby customers, and the more competitive is the outcome.

We move on to the model in Section II. In Section III we present a discussion of the equilibrium incentives of the banks and the results of simulations of the model. Section IV provides discussion and interpretation, and Section V provides a summary and conclusion.

II. The Model

Two banks serve the market. Serving a customer requires the expenditure of fixed costs, f. Customers are located (uniformly distributed) on the unit interval, [0,1]. The banks are located at 0 and 1, the endpoints of the interval. Consumers use banks for check transaction services, q_i. Banks charge explicit prices, p_i, i = 1,2, for deposit services. Consumers write checks to others on the unit interval in a uniform pattern. We refer to this pattern as isotropic check exchange. This assumption implies that for equal prices of check services, inflow and outflow of checks are balanced across banks (even if market shares are not).

Given income y, and check consumption q_i, a consumer located at x and using bank i has utility:

$$y + v_0 - t|x - x_i| + u(q_i),$$

where v_0 represents the fixed surplus from being able to write checks to anyone in the market (the network effect), $t|x - x_i|$ represents the cost of using a bank at address x_i (which is different from where the consumer is located, x), and the variable gross surplus $u(q_i)$. We let

$$u(q_i) = \ln q_i.$$

This yields

$$u'(q_i) = p_i \text{ if and only if } q_i = (1/p_i).$$

This assumption gives us unitary price elasticity of check demand.

The consumer's variable net surplus is equal to

$$v(p_i) = \max\{u(q_i) - p_i\, q_i\} = \ln(1/p_i) - 1 = -\ln p_i - 1.$$

For prices p_1 and p_2 charged by the banks for check services, market shares are determined by consumers choosing the bank that yields the highest surplus. So a consumer at $x = \alpha$ is indifferent between the two banks if and only if:

$$v(p_1) - t\,\alpha = v(p_2) - t\,(1-\alpha),$$

or:

$$\alpha = (½) + \sigma\,(v(p_1) - v(p_2)),$$

where $\sigma = 1/(2t)$ is an index of substitutability between the banks. In our case we have

$$\alpha = (½) + \sigma\,(\ln p_2 - \ln p_1) \qquad (1)$$

Note that $(\partial\alpha/\partial p_1) = -(\sigma/p_1)$, and $(\partial\alpha/\partial p_2) = (\sigma/p_2)$. Average per-capita welfare is given by

$$W = \alpha\, v(p_1) + (1-\alpha)\, v(p_2) - (t/2)(\alpha^2 + (1-\alpha)^2).$$

The last term represents the average customer's disutility from not being able to consume banking services at her ideal location. Substituting for $v(p_i)$, we have

$$W = \alpha\,(-\ln(p_1) - 1) + (1-\alpha)\,(-\ln(p_2) - 1) - (t/2)(\alpha^2 + (1-\alpha)^2).$$

Providing check services is costly. Each check transaction is assumed to incur costs of c by the bank on which the check was drawn. In addition, the process of collecting a check costs (at least) h, by the bank that collects the check (whether the check was drawn on that bank or on the other bank), and the process of paying a check costs h for the bank that pays the check (again whether or not it was drawn on that bank). In summary, there are costs to a bank to be in business, f; costs of account maintenance when the account has active transactions, c; and costs of collecting, h, and paying, h, for any check transaction. The assumption that the costs are the same for "on-us" transactions as they are for "on-others" transactions is a conservative assumption intended to highlight the strategic issues in check exchange while preserving symmetry between on-us and on-others transactions to a greater degree than is empirically true. Throughout the paper, however, we will assume that the cost to collect and pay a check internally is zero; that is we will assume that h = 0. In the best of circumstances, under a clearinghouse agreement the costs of collecting and paying a check externally is zero as well. When other ways of collecting and paying checks are introduced, the costs of collecting or paying the checks externally will be greater than zero.

II.1. Symmetric clearinghouse agreement

In the initial "regime" that we consider, the banks have agreed to a clearinghouse, or bilateral interchange agreement. Under this agreement, the banks exchange their checks at a convenient time and place, and each incurs cost, h, in collecting the other bank's checks, which is the same as if the check had been an on-us transaction. The banks agree not to impede collection of payment in any way.

Again, to simplify matters (and with no loss of generality for linear costs), we let h = 0. Collecting checks is done at zero cost (both internally and across banks).

A bank's profit in this case is given by

$$\Pi_i^C = \alpha_i[(p_i - c)q_i - f], \text{ for } i = 1,2, \text{ and where } \alpha_1 = \alpha, \text{ and } \alpha_2 = 1 - \alpha.$$

The first order conditions for maximization of profit are given by

$$(\partial\Pi_i^C / \partial p_1) = \alpha_i[(p_i - c)(\partial q_i / \partial p_i) + q_i] + (\partial\alpha/\partial p_i)[(p_i - c)q_i - f] = 0, \text{ for } i = 1,2.$$

From the first order conditions we find that

$$(p_i - c)/p_i = (\alpha_i + \sigma f)/(\alpha_i + \sigma) \qquad (2)$$

Equation 2 states that the price-cost margin for each firm is equal to a ratio depending on its market share, the degree of substitutability between banks, and the fixed cost.

Lemma 1: For sufficiently small levels of costs, f and c, there exists a unique, symmetric, full coverage equilibrium in which both firms have equal market shares. Hence $\alpha_1 = \alpha_2 = (1/2)$. Prices are then given by equation (2).

Proof. Because the profit function is strictly concave, the first order condition specifies a unique maximand. Hence, the existence and uniqueness of the symmetric equilibrium follow from that fact and the continuity of the profit function. For small fixed costs and marginal costs, the equilibrium will be full coverage; that is, α will be 1/2 (all customers will be served by one of the two banks).

Because check demand has unitary price elasticity, and because of the isotropic check demand, firms always break even on interchange business. □

Notice that when the banks become perfectly substitutable (that is, when t = 0, or $\sigma = \infty$) equation (2) shows that $(p_i - c)q_i = f$.

In other words, when the check market is highly competitive, the prices charged are "Ramsey (or contestable) prices." Ramsey prices are the lowest prices that satisfy the budget constraint. Vigorous competition between the banks is fully preserved under the bilateral interchange agreement.

II.2. Delayed availability

Now we consider the case in which bank 1, which is assumed to control the clearinghouse, imposes a cost on bank 2 for the collection of the checks of bank 1. So for every check of bank 1 that bank 2 collects, a cost, d, is imposed by bank 1 on bank 2. Conversely, this cost is enjoyed by bank 1 as additional revenue. This cost could be interpreted as "delayed availability," in which the dominant bank redefines the "availability zones" so as to have bank 2's checks take an extra day to settle. In this case bank 2 loses "float" earnings and bank 1 gains them. It could also be interpreted as remote disbursement, in which the dominant firm issues its checks from a point (say at -1 on the line) distant from the market, but continues to collect checks from its merchants at its in-market location. Now the profit functions are given by

$$\Pi_1^A = \alpha_1[(p_1 - c)q_1 - f] + \alpha_1 \alpha_2 d\, q(p_1) \text{ for bank 1, and}$$

$$\Pi_2^A = \alpha_2[(p_2 - c)q_2 - f] - \alpha_1 \alpha_2 d\, q(p_1) \text{ for bank 2.}$$

In this case we can examine the first order conditions and solve for the price-cost margins as in the clearinghouse agreement. We have the following expressions for the prices, and shares.

$$(p_1 - c)/p_1 = (\alpha_1 + \sigma f)/(\alpha_1 + \sigma) - [(\sigma(\alpha_2 - \alpha_1) d + \alpha_1 \alpha_2 d)/ (\alpha_1 + \sigma) p_1], \text{ for firm 1, } (3)$$

$$(p_2 - c)/p_2 = (\alpha_2 + \sigma f)/(\alpha_2 + \sigma) - [(\sigma(\alpha_2 - \alpha_1) d)/ (\alpha_1 + \sigma) p_1], \text{ for firm 2, and} \qquad (4)$$

$$\alpha = (1/2) + \sigma (\ln p_2 - \ln p_1) \qquad (1).$$

Lemma 2: There exists an asymmetric equilibrium under the delayed availability policy of bank 1, characterized by the solutions to equations (1), (3) and (4), for sufficiently small d.

Proof: The equilibrium correspondence is continuous in d. A symmetric equilibrium exists when d = 0; for small values of d the equilibrium exists; and examination of (3) and (4) characterize the equilibrium.

II. 3. Direct presentment

Banks have the right of direct presentment of checks. That is, by expending a cost, bank 2 can directly present checks to bank 1 and gain better availability. Presentment is costly, though, for both the collecting and paying bank. We capture this costliness of presentment by allowing the costs of collecting and paying for an on-other's check, $c_0 > 0$ (however, these costs apply only to interchange items; internal costs of item processing, h, remain 0). We consider the case in which both banks directly present checks to one another. Hence both incur the cost c_0 in collecting and paying for checks.

Profits in this case are given by

$$\Pi_i^D = \alpha_i[(p_i - c)q_i - f] - \alpha_1 \alpha_2 c_0 (q_j + q_i) \text{ ; where } i, j = 1,2, i \neq j.$$

The first order conditions for the maximization of these expressions lead to expressions for the price cost margins that are

$$(p_i - c)/p_i = (\alpha_i + \sigma f)/(\alpha_i + \sigma) + [(\alpha_i^2 c_0)/(\alpha_i + \sigma)](1/p_i) - [\sigma((\alpha_i - \alpha_j)(c_0))/((\alpha_i+\sigma) (p_j + p_i))].(5)$$

Comparing equation (5) and equation (1), we see that in a symmetric equilibrium (when $\alpha_i = \alpha_j$) prices are higher when both banks directly present checks to one another than in the case of the clearinghouse agreement. Again, by continuity of the equilibrium correspondence we have existence of equilibrium for small levels of c_0.

Lemma 3. There is a unique symmetric equilibrium, characterized by equation (5), when both banks directly present to one another, for levels of c_0 sufficiently small. The prices from (5) are strictly higher, and welfare is lower than in the case of the clearinghouse agreement.

III. Simulation Results and Equilibrium Behavior

Bank 1 is assumed to set the terms of the clearinghouse agreement (or in any case to set delayed availability for the collection of its checks). Bank 2's only response is either to accept the delayed availability and act according to the incentives it determines for bank 2 or to directly present checks to bank 1. Bank 1, in turn, directly presents checks to bank 2. The banks' strategic possibilities are shown in the game of Figure 1. The payoffs to the game are determined according to the pricing policies and associated equilibrium profits determined by the output and check market behavior described above.

The banks are assumed to follow subgame perfect equilibrium strategies. Hence, bank 2, when forced to choose between accepting delayed availability or directly presenting checks, will choose the option that yields it higher profit. Bank 1 chooses between offering the symmetric clearinghouse agreement or imposing delayed availability. It does so knowing the outcome of bank 2's deliberations, and choosing the option that yields it the highest profit.

III. 1. Simulation results

We simulated the model for various sets of parameters.[3] The results of the simulations are robust with respect to changes in f, c, d, and c_0. We present (typical) simulation results for the following parameter set:

f = .001

c = .01

d = .0000001

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[3]We've solved the model for various sizes of f, c, c_0, and d. We used values of the parameters in which both firms would be active in equilibrium. The solutions reported here are representative of all the model's solutions with different sizes of f, c, c_0, and d.

$c_0 = .0000125$

The (direct) cost of direct presentment in this simulation is roughly ten times the (direct) cost of delayed availability. For costs of direct presentment much lower than this level, bank 2 always prefers direct presentment to delayed availability, and the equilibrium outcome is the symmetric clearinghouse agreement.

Simulations of the model using various parameter values yield the following result:

Result 1: For parameter values that yield equilibrium behavior in the check market, the clearinghouse game has two possible equilibria: for levels of σ sufficiently high, above some level, σ^*, the symmetric clearinghouse agreement is the equilibrium; for levels of σ below σ^* the delayed availability outcome is the equilibrium. Direct presentment is not an equilibrium. Lowering the cost of direct presentment, c_0, decreases the range over which delayed availability is an equilibrium.

Discussion. The proposition establishes σ as a crucial parameter of the model. Let's examine the way payoffs, dependent on σ, affect the decisions of the banks ($\sigma = (1/2t)$ is an index of the substitutability of the banks' services; t is the cost of transportation for consumers). Consider the situation under the symmetric clearinghouse agreement; under the assumption that $h = 0$, the costs of on-us and on-others check transactions are equal. Furthermore, the banks are symmetric in their positions in the check market. With these incentives, the banks' pricing policies are determined by their strategic interaction, which is more or less competitive as σ is larger or smaller. With a larger σ, each bank has an incentive to price more competitively because its customers could be attracted to the other bank if the other bank's prices are slightly lower; on the other hand, with a lower σ, customers are less prone to change banks because of small differences of price, and so both banks price at levels higher than the competitive level.

Under the delayed availability arrangement, the banks' incentives are altered. Bank 2 now faces higher "costs" for collecting the checks of bank 1 (because it suffers a delay of availability), while still enjoying the zero cost of on-us checks. There are two cases, depending on how substitutable the banks' services are for one another. When $\sigma \geq 1$, bank 2 has an incentive to lower its price, p_2, to attract customers and expand its market share in the retail deposit market, so that it will receive a greater portion of the checks internally, and a smaller percentage from bank 1's customers. Nonetheless, because of lower margins and the lost float earnings, delayed availability results in lower profits for bank 2 than the bilateral clearinghouse agreement.

When the banks' services are quite poor substitutes, that is , when $\sigma < 1$, the incentive to lower price by bank 2 is blunted: bank 2 does so poorly at attracting customers that it instead raises its prices in that region of the parameter space (thus losing market share), in effect passing on its higher costs to its customers. Bank 1 (as we will explain in more detail next) charges a higher price than bank 2, so the prices of both firms are increased (relative to the symmetric clearinghouse agreement) and both firms enjoy higher profits. The delayed availability acts as a device to collude, extracting rents from customers.

Bank 1, on the other hand, is enjoying the increased float earnings from checks collected by bank 2, relative to its on-us checks. Because of that, bank 1's incentive to raise its price is stronger than bank 2's incentive to do so, and in equilibrium bank 1's price is higher than bank 2's price. Bank 1's increase in profits depends on the success of bank 2 in increasing its market share. If the banking market is highly competitive (i.e., σ is much larger than 1), bank 2 will win a significantly larger market share when it lowers its price. In that case, the increased vigor of the price competition generated by bank 2 swamps the increased float earnings generated by the delayed availability policy. If the market is less competitive (i.e., σ is small, but still possibly greater than 1), delayed availability can work to the advantage of bank 1, and bank 1 will wish to implement it.

Bank 2 can respond by directly presenting to bank 1. Relative to the symmetric clearinghouse agreement, directly presenting checks is costly and results in higher consumer prices. Profits, correspondingly, are reduced from their levels under a symmetric clearinghouse agreement. Whenever bank 2 prefers direct presentment to the delayed availability outcome, bank 1 will not attempt to implement delayed availability in the first place. Bank 2's preference for delayed availability is influenced by the size of c_0, the cost of paying and collecting on-others items under direct presentment. The larger c_0 is, the less likely it is that bank 2 prefers direct presentment to delayed availability.

Figure 2 shows the difference in profits of bank 1 under the delayed availability strategy and the profits under the symmetric clearinghouse agreement (multiplied by a scaling factor). Figure 3 shows the difference in profits of bank 2 under the delayed availability strategy and the profits under direct presentment. For all $\sigma < 6$, Figure 2 shows that bank 1 prefers the delayed availability strategy to the symmetric clearinghouse agreement. For all $\sigma < 4$, bank 2 prefers delayed availability to direct presentment. Hence, for all $\sigma < 4$, bank 1 will choose delayed availability, and for $\sigma > 4$, bank 1 will choose the symmetric clearinghouse agreement. For $4 < \sigma < 6$, bank 1 would prefer delayed availability, but were it to choose delayed availability, it would find itself in the direct presentment outcome, which is less preferable than the symmetric clearinghouse agreement and so it will choose the symmetric clearinghouse agreement outcome.

The tables in the appendix show prices, profits, market share for bank 1, and average per capita welfare for a range of σ, under the various arrangements.[4]

The simulation reveals an important consideration for policy in this market: welfare varies with the equilibrium in the market.

Result 2: In both equilibria, welfare rises with σ. In the delayed availability equilibrium, for small levels of σ, welfare is decreased from its level under the symmetric clearinghouse agreement; as σ rises (and if c_0 is sufficiently high), welfare is increased relative to the symmetric clearinghouse agreement.

Discussion. Figure 4 shows how welfare varies with σ under the equilibrium outcomes. Why is welfare lower under delayed availability than under the symmetric clearinghouse agreement for low levels of σ? Because bank 2's incentive to lower its price to gain market share (in an attempt to evade the "tax" of delayed availability) is muted when σ is small. The banks are sufficiently poor substitutes that price decreases by bank 2 do not result in significant gains in market share,

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[4]The magnitude of the differences in prices and profits across outcomes is rather small. This is an artifact of the logarithmic utility which we employ for tractability. The following calculation shows that the delayed availability cost is small relative to the resulting difference in consumer welfare. For σ = .5, welfare falls by .0139 percent. This decrease in welfare was caused by the imposition, by bank 1, of a delayed availability "tax" of .0000001 per unit of output. In the symmetric clearinghouse agreement (at σ = .5) bank 2 produces q = 49.95 (approximately), so its total tax (measured in a static sense) is roughly equal to .0000001(.5)(49.95) = .000002498. Its profits are approximately .249. Hence the increased cost as a percentage of its profits is .001. In other words, the total tax is roughly a one-tenth of a basis point subtraction from the firms *profits* (not from its total revenue; the cost represents only .0002 percent of total revenue, i.e. 2 one-hundredths of a basis point). Nonetheless, the decrease in social welfare is more than 1 basis point, a multiple of more than 50 times the amount of the tax the firm pays as a percentage of its revenues (and more than 10 times the amount of the tax the firm pays as a percentage of profit).

so bank 2 either raises its price or lowers it only marginally. Bank 1 raises its price, and, as a result, consumer welfare falls.

As σ rises, however, bank 2 has increased incentives to lower its price, and although bank 1 maintains its price above that of bank 2, it can set its price at a level below what its price would be under the symmetric clearinghouse agreement and still earn greater profits under delayed availability (consider $\sigma = 4$ in the tables, for example). In such a case, both banks charge lower prices, and the consumer benefits from the increased price competition (at the expense of bank 2, of course).

For $\sigma \geq 1$, as c_0 gets smaller, bank 2 tends to prefer direct presentment to delayed availability. However, for $\sigma < 1$, for even very small levels of c_0, bank 2 prefers delayed availability, because its profits are greater than they are even under the symmetric clearinghouse agreement. So with very small c_0, the only equilibrium delayed availability occurs when $\sigma < 1$, in which case welfare is definitely lower than under the symmetric clearinghouse agreement.

Results 1 and 2 characterize the outcomes of the model. Delayed availability will be employed by bank 1 to advantage itself relative to its rival so long as the retail banking market is not too competitive. When the banks do not compete for each other's customers, that policy can work to the advantage of bank 2. When the banks are imperfect substitutes for one another, the policy of delayed availability results in reduced welfare. As the banks are better substitutes, welfare can increase (relative to the symmetric clearinghouse agreement) because of the increased vigor of price competition bank 2 engages in under delayed availability. As the banks become increasingly substitutable, the benefits to bank 1 from delaying the availability of bank 2's checks are eroded by the price competition from bank 2.

IV. Discussion and Interpretation

The model investigates a privatized check exchange system. No Federal Reserve processing facilities are described in the model. What is the role of the Federal Reserve in this model? One interpretation consistent with this model is provided in part by Gilbert (1991). In that article, the Fed provides a competitive alternative to a bank clearinghouse. With the Fed as a next best alternative, a bank is offered a good contract with the clearinghouse; otherwise it can use the Fed and receive availability nearly as good as that offered by the clearinghouse to their most favored members.

The Fed clears checks nationwide. By virtue of its ability to clear checks in all local markets, it then acts as an outside option for those banks that are otherwise at risk of being subject to the delayed availability equilibrium. The model would suggest that the Fed would operate in smaller markets, assuming that there are some scale economies in check clearing of which a local bank could not take full advantage, and in markets that would otherwise be subject to the delayed availability equilibrium, that is, concentrated banking markets.

In which markets does the Fed do a significant share of the local check clearing? The markets in which the Fed does a significant share of the business are roughly characterized as nonurban markets. These are markets that are both relatively small and whose deposit competition is significantly less competitive than urban market deposit competition.

Amel (1996) documents that the roughly 300 urban markets for depository services were significantly less concentrated than the roughly 2600 nonurban markets, with the average Herfindahl-Hirschman Index (HHI) being 1300 for urban markets in 1994, and 3724 for nonurban markets.[5] Second, the recent work of Hannan and Prager (1996) showed significant price effects from what they defined as substantial horizontal mergers in banking markets.[6] They varied the definition, but in their basic results, a substantial merger was defined as one that increased the HHI by at least 200 points, leaving a post-merger HHI of at least 1800. That is a level of concentration well above that found in most urban markets and below that found in nonurban markets. Their work complements that of Berger and Hannan (1989) who show that structural concentration measures in banking markets result in pricing that is less advantageous to consumers. Amel (1996) and Berger and Hannan (1989) discuss some of the reasons that deposit relationships can give rise to pricing power in concentrated markets, in contrast to other industries, such as supermarkets, which also tend to be more concentrated in nonurban markets.

This interpretation then is that the Fed service tends to be more in demand in small deposit markets and in deposit markets that are relatively noncompetitive. The interpretation would also point to areas in which the costs of direct presentment are relatively high as being areas in which the Fed would be a more preferred alternative (otherwise the threat of direct presentment would discipline bank 1 and a symmetric clearinghouse agreement would be offered). These areas would tend to be where direct presentment would require travel of longer

[5]The HHI is an index of concentration in a market. It is defined as the sum of squared market shares of the firms in the market.

[6]Hannan and Prager's results show that decreases in market deposit rates (i.e., interest rates paid on deposit accounts) are larger in markets that experience a substantial merger than in markets that did not experience a substantial merger over the same period. This result is especially significant because of the potentially offsetting efficiency gains associated with such mergers (which would tend to increase deposit rates), the truncated nature of the sample (large mergers are not allowed), and the scrutiny all such mergers receive from the Department of Justice.

distance than otherwise; again this would tend to be true in nonurban areas.

This interpretation of the model suggests that were the Fed to exit the provision of check services, consumer welfare could either rise or fall. The calculation to determine the effect on welfare of the exit of the Fed would be to count the markets (in which delayed availability is the equilibrium) in which σ is in the range in which welfare is lowered (and calculate by how much), count the markets in which σ falls in the range in which welfare is raised (and calculate by how much), and then sum the two amounts.

Do we have any suggestion about how this calculation might turn out? One observation is that the model is unrealistic in that consumers typically are grouped in towns (islands), rather than being evenly distributed across space. This observation might lead one to believe that the incentives for bank 2 to lower its prices (the proximate cause for the increase in welfare under delayed availability) are exaggerated in the model. Bank 2 is unlikely to gain much market share in other towns by lowering its price. Another fact to consider is that check collection is typically less concentrated than the pattern assumed in the model: one bank may, even in a relatively concentrated market, only have one-third of its items processed as on-us. In such an unconcentrated check collection system, lowering one's prices for deposits may not yield any perceptible increase in on-us items. Hence, bank 2 would have very weak incentives to lower its prices. On the other hand, another observation is that check writers do not typically write checks in an isotropic pattern as assumed in the model. If check writing is more locally confined to towns, lowering price may lead to increased market share.

What type of regulation of a privatized check market would be warranted under the interpretation suggested here? Bank 2 would wish to negotiate a clearinghouse agreement that would provide it substantially similar terms to those it received under the Fed's provision of services. If bank 2 could ask for binding arbitration of the clearinghouse agreement (should it not be offered favorable terms), then it would have the incentive to do so when the terms offered fell short of its desires. The Fed could arbitrate such conflicts. This is quite similar to the role the FCC will play under the Telecommunications Act of 1996 when firms do not believe they are being offered fair terms of access to local telephone network facilities. This regulation has the potential to eliminate welfare-enhancing delayed availability arrangements as well as those that tend to decrease welfare.

V. Summary and Conclusion

The model analyzed in this paper investigates the basic incentive that any bank or clearinghouse has regarding access to its facilities (in this case its payment facilities): whether to withhold its facilities from its rivals to gain advantages in the retail marketplace. In interconnected systems, each bank (or firm) is both a supplier of intermediate goods to its rivals, as well as a rival. The bank's incentives to supply the intermediate goods can and will be influenced by its attempt to gain advantages over the rival. These incentives can lead either to socially beneficial or costly competition. The model here does not address other issues in check exchange, such as remote presentment practices, but it is capable of addressing such issues.

We construct and simulate a model of check exchange to examine the incentives a bank has to delay the availability of check payment. The potentially disadvantaged bank has the option of directly presenting checks to the first bank. We find that if the retail banking market is highly competitive, the bank will not engage in such practices, but if the retail banking market is imperfectly competitive, the bank will find it advantageous to restrict access to its facilities.

Lower costs of direct presentment can reduce (but not eliminate) the range over which these practices are employed. The practice of delayed presentment can either reduce or increase welfare, again depending on the degree of competition in the market. The model suggests that, were the Federal Reserve System to exit the business of check processing, practices such as delayed presentment would be more prevalent in smaller, concentrated markets, such as the nonurban banking markets.

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Appendix

Symmetric Clearinghouse Agreement	σ = .5	σ = 2	σ = 4	σ = 6	σ = 8
Π_1^C, Π_2^C	.24975, .24975	.0999, .0999	.0555, .0555	.03842, .03842	.029382, .029382
p_1, p_2	.02000, .02000	.012513, .012513	.011261, .011261	.010844, .010844	.010636, .010636
α	.5	.5	.5	.5	.5
W	2.66102	3.31853	3.45514	3.50329	3.52792

Delayed Availability	σ = .5	σ = 2	σ = 4	σ = 6	σ = 8
Π_1^A, Π_2^A	.24998, .24977	.1, .099	.055, .054	.038, .037	.029, .028
p_1, p_2	.020026 .020029	.012512, .012509	.011259, .011256	.010842, .010839	.010633, .010630
α	.500010	.49962	.49896	.49830	.49764
W	2.66065	3.31868	3.45544	3.50366	3.52832

Direct Presentment	σ = .5	σ = 2	σ = 4	σ = 6	σ = 8
Π_1^D, Π_2^D	.24952, .24952	.09945, .09945	.05498, .05498	.03787, .03787	.02881, .02881
p_1, p_2	.020026, .020026	.012514, .012514	.011262, .011262	.010845, .010845	.010636, .010636
α	.5	.5	.5	.5	.5
W	2.66071	3.31840	3.45507	3.50325	3.52788