Transactions Costs, Inflation, and the Variety of Intermediation Services

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1. INTRODUCTION

In the partial equilibrium inventory models of money demand of Baumol (1952) and Tobin (1956), economic agents hold “money,” which is dominated in rate of return by other assets, because money is required to make transactions and it is costly to make “trips to the bank” to exchange these other assets for cash. In general equilibrium versions of these models, such as Jovanovic (1982), transactions costs explain the rate of return dominance of money. These general equilibrium models are useful since they yield predictions and normative implications concerning the effects of changes in the environment, such as changes in government policy. For example, Jovanovic’s model predicts that higher inflation reduces average money balances and increases the transactions costs associated with trips to the bank. As in Friedman (1969) and Sidrauski (1967), the money stock should be managed so that deflation occurs at the rate of time preference. However, in contrast to the Friedman rule, optimal deflation does not equate the real return on money to that on alternative assets as, at the optimum, agents incur transactions costs in selling productive assets.

If we are to take seriously the interpretation of the transactions costs in Tobin-Baumol-type models as trips to the bank, this must imply, in the absence of entry restrictions, that there are fixed costs of financial intermediation. Otherwise, the variety of intermediation services (where variety could be in terms of the location

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dimension or other characteristics) would increase without bound, eliminating these transactions costs. Support for the notion that financial intermediation is an activity which is subject to economies of scale can be found in theories of financial intermediation which rely on the existence of asymmetric information. Examples are Boyd and Prescott (1986), Diamond (1984), and Williamson (1986b).

The purpose of this paper is to construct a simple, tractable model where there are fixed costs of financial intermediation in addition to costs of transacting with intermediaries, and to show that such a model can lead us to quite different conclusions from those of models stemming from the work of Tobin and Baumol.

Here, as in the industrial organization literature (see Dixit and Stiglitz 1977, Salop 1979, and Spence 1976, for example), fixed production costs for intermediation services permit a model of imperfect competition for the intermediation industry. This model is similar to Salop (1979), though there are complications here due to the fact that firms in our model do not produce goods, but intermediate between borrowers and lenders. There are costs to both borrowers and lenders of transacting with intermediaries, and lenders incur no costs in holding fiat money. In contrast to Tobin-Baumol and Jovanovic (1982), there is no restriction in our model that fiat money be used in transactions. The model of imperfect competition for the intermediation industry is embedded in an overlapping generations structure (see Samuelson 1958 and Wallace 1980), so that there exist equilibria where intrinsically useless fiat currency is valued.

As in inventory models of money demand, transactions costs explain the rate of return dominance of fiat money by other assets. However, as the fixed cost of intermediation goes to zero in our model, rates of return tend to equality, since all varieties of intermediation services are produced in this case.

Given results from the literature on product diversity (Dixit and Stiglitz 1977, Spence 1976, Salop 1979, Koenker and Perry 1981, and Mankiw and Whinston 1986), we would not expect an optimal variety of intermediation services to be produced in equilibrium, and government intervention which affects entry into the industry may be welfare-improving. Two interventions which are special to the intermediation industry are minimum reserve requirements, which act as a tax on intermediation, and changes in the money growth rate, which affect the steady state inflation rate and the rate of return on fiat money (the price of the "outside good"). We allow for these interventions in our model, consider their equilibrium effects, and derive conclusions for the optimal degree of intervention.

In contrast to Jovanovic (1982), an increase in the steady state inflation rate, brought about by an increase in the growth rate of fiat money, reduces transactions costs incurred by borrowers, may cause a decrease in transactions costs for depositors at intermediaries, and reduces nominal interest rates. These radically different effects are due to the fact that the variety of intermediation services increases with inflation. That is, a fall in the rate of return on fiat money increases the demand for intermediary liabilities, thus increasing profits and drawing more
firms into the industry. As the number of financial intermediary firms increases, each trip to the bank is on average less costly.

An increase in the minimum reserve requirement, which we might expect to reduce the equilibrium variety of intermediation services, in fact has ambiguous effects. There are two factors, one which tends to increase intermediary profits and to encourage more entry, and another which has the opposite effect. Either factor may dominate.

In this model, deflation is optimal, and this is independent of the required reserve ratio. However, there is no relationship between the optimal rate of deflation and a rate of time preference. Instead, in a laissez-faire equilibrium with a fixed supply of fiat money and a constant price level, there are too many intermediary firms. Deflation reduces the amount of product variety and improves welfare, in spite of the fact that this brings about an increase in nominal interest rates and may increase the costs of transacting with intermediaries for all agents. As in the industrial organization literature, the result that deflation is optimal is not likely to be robust, since there may be too little diversity rather than too much in an unfettered equilibrium. Either result might occur if we were to consider different models of imperfect competition or if we changed our model's specification (see Dixit and Stiglitz 1977, Spence 1976, Salop 1979, Keonker and Perry 1981, and Mankiw and Whinston 1986). However, the fact that we can get implications that are radically different from those of inventory-type transactions cost models of money demand, shows that ignoring fixed costs of intermediation is not innocuous.

The remainder of the paper is organized as follows. In section 2 we construct the model. Section 3 contains a discussion of intermediation industry equilibria, and section 4 introduces money supply growth in general equilibrium. In section 5 we discuss welfare, and section 6 is a conclusion.

2. THE MODEL

This is a model of "spatially" competitive financial intermediaries, embedded in an overlapping generations structure. There are three types of agents in the economy: consumers, financial intermediary firms, and the government.

In each period \( t = 1, 2, \ldots, \infty \), \( N \) consumers are born who each live for two periods. Each consumer has a utility function \( u(c_1, c_2, e_1, e_2) \), where \( c \) denotes consumption of the nonstorable consumption good, and \( e \) is effort expended in carrying out transactions. Subscripts denote the period of life. We assume that

\[
u(c_1, c_2, e_1, e_2) = \begin{cases} -\infty, & c_1 < 1 \\ c_2 - e_1 - e_2, & c_1 \geq 1 \end{cases}.
\]

That is, 1 unit of consumption is required for subsistence in the first period of life, and if first period consumption is at or above this level, utility depends only on second-period consumption minus transactions effort. A fraction \( \alpha (0 < \alpha < 1) \)
of each generation are “lenders,” who receive an endowment of 2 units of the consumption good in the first period of life and zero units in the second. The remaining fraction are “borrowers” who are endowed with zero units in the first period of life, and \( y \) units in the second. Lenders will then save 1 unit of the consumption good, and borrowers will borrow one unit in the first period of life. We assume that \( y \) is always large enough for a lender to be able to repay the interest and principal on her loan.

Lenders and borrowers in each generation are distributed uniformly on a circle of unit circumference, so that on any portion of the circumference of the circle of length, \( \delta \), the number of lenders and \( (1-\alpha)\delta N \) borrowers are born in each period. Also, \( K(t) \) financial intermediary firms, index by \( i = 1,2,...,K(t) \), take up fixed locations on the circle at the beginning of each period, \( t \). These intermediaries issue one-period deposit liabilities and make one-period loans to consumers. As an alternative to acquiring deposits at financial intermediaries, lenders can save by holding fiat money, units of which are intrinsically useless, unbacked, government liabilities.

We assume that there are transactions costs associated with buying and selling intermediary deposits, and with taking out and repaying intermediary loans. For an individual consumer, these costs are proportional to the shortest “distance” of the consumer from the intermediary firm, along the circumference of the circle. The proportional transactions cost to holding an intermediary deposit (loan) is \( x_1(x_2) \) units of effort.

We assume that there are no costs associated with buying and selling fiat money. Therefore, there is an implicit assumption that there exists a legal restriction or some other barrier that prevents financial intermediaries from issuing perfect substitutes for fiat money (Wallace 1983). Transactions costs have a simple interpretation in terms of time spent in “trips to the bank” to make and withdraw deposits, and to take out and repay loans. Thus, someone who lives next door to a bank incurs zero costs in transacting with it.\(^3\) There are other interpretations of these transactions costs that correspond to this structure, in terms of the characteristics of intermediary assets and liabilities, and how well these characteristics fit the requirements of a heterogeneous population of consumers.

We assume that intermediaries cannot determine the location of consumers who arrive to carry out transactions, and therefore cannot price-discriminate. At time \( t \), intermediary \( i \) offers a payment at time \( t+1 \) of \( r_i(t) \) for each unit of the consumption good deposited at time \( t \), and offers to loan out one unit at time \( t \) in return for a payment of \( r_i^+(t) \) at time \( t+1 \). At time \( t \), each lender then holds the asset which solves

\[
\max_{i} \left[ \max_{i} \left( r_i^-(t) - x_i y_i(t), \frac{p(t+1)}{p(t)} \right) \right], \quad i = 1,2,...,K(t)
\]

\(^1\)This will always be the case in the equilibria we examine where fiat money, which can be held without cost, is valued. However, note that lenders might choose disposal of 1 unit of the consumption good when young if no asset pays a return that will compensate for transactions costs.

\(^2\)We could also have assumed a fixed cost to holding an intermediary deposit or loan, but this would make no difference for any qualitative implications.
where \( y_i(t) \) is the shortest arc length on the circle between the consumer and the \( i^{th} \) intermediary, and \( p(t) \) is the price of fiat money in terms of the consumption good at time \( t \). Similarly, borrowers hold the intermediary liability which solves

\[
\max_i \{ -r_i(t) - x_2 y_i(t) \}, \quad i = 1, 2, \ldots, K(t) .
\]

For each intermediary, there is a fixed location cost of \( F \) units of the consumption good, which is incurred when the intermediary takes deposits and makes loans. This fixed intermediation cost might be motivated in a number of ways. For example, consider the following parable. We might suppose that consumers can “hide” from an intermediary (or any agent) in the second period of life. However, a machine can be acquired at a fixed cost, \( F \), that can be used to tag agents and find them in the following period. Due to the nature of the tagging process, a machine must be located at the intermediary’s location, and it is immobile during its useful life. When investment is made in an intermediation machine, the machine is good only for applying tags in one period and reading them in the next. Intermediation machines thus prevent the repudiation of one-period debts.\(^3\) We can think of the investment in an intermediation machine as representing investment by an intermediary firm in physical capital, human capital (such as the training of loan officers), and advertising.

Increasing returns to scale in financial intermediation are a feature of theories of intermediation based on asymmetric information, including Boyd and Prescott (1986), Diamond (1984), and Williamson (1986b). Fixed costs of intermediating between lenders and borrowers are also discussed in Williamson (1986a).

Given the fixed cost of intermediation, it is not feasible for private intermediaries to occupy each point on the circle. The number of intermediary firms must necessarily be finite, and this will tend to generate an imperfectly competitive market structure. From the industrial organization literature (Spence 1976, Dixit and Stiglitz 1977, Salop 1979, and Mankiw and Whinston 1986), we know that imperfectly competitive structures do not, in general, generate the optimal degree of “product variety” in the absence of government intervention. In our model, the optimal number of intermediaries will be determined by trading off the transactions costs incurred by lenders and borrowers against fixed costs of intermediation. Transactions costs for borrowers tend to fall as the number of intermediaries rises, while fixed costs rise with the number of intermediaries. With respect to lenders’ transactions costs, there are two opposing effects. As the number of intermediaries rises, the quantity of deposits increases to finance fixed intermediation costs. This tends to increase transactions costs for lenders, as

\(^3\)We assume that agents have access to a costless legal system, so that agents who can be found do not repudiate their debts. Since intermediaries are fixed in location, they can be found costlessly, and never repudiate their debts. Note that a single agent, such as the government, could not use the technology to disseminate information on all agents and eliminate duplication costs, since an individual agent needs the machine to read tags.
fewer of them hold fiat money. On the other hand, for those holding deposits, transactions costs tend to be lower as the number of intermediaries increases.

In this paper, we look at two types of government actions which have their primary effects on the intermediation industry, and which will affect the diversity of intermediation services offered in equilibrium. First, we examine the effects of changes in the money growth rate, which bring about changes in the rate of return on fiat money (i.e., the price of the “outside good” in this model). Second, we look at changes in minimum reserve requirements. A reserve requirement is often viewed as a tax on intermediation (Fama 1980).

3. INTERMEDIATION INDUSTRY EQUILIBRIUM

The equilibrium concept which we will use here is similar to that in Salop (1979), though the nature of intermediation and our overlapping generations structure make the model quite different. We examine only monetary equilibria, where the price of fiat money is positive in each period, $t = 1, 2, \ldots, \infty$. We look first at industry equilibrium in period $t$, which will be affected by that part of the economy outside the intermediation industry only through this period’s and next period’s prices of fiat money, $p(t)$ and $p(t+1)$. We assume that each intermediary treats $p(t)$ and $p(t+1)$ as fixed parameters.4

We will assume that $K(t)$ intermediary firms enter the market at time $t$, choosing their locations so as to achieve equal spacing on the unit circle. These locations are then fixed, and each firm sets its deposit interest rate and loan interest rate so as to maximize profits, making Nash conjectures concerning the behavior of other intermediary firms. In examining the pricing decisions of the $i$th intermediary firm, we suppose that $r_d^i(t) = \bar{r}(t)$ and $r_d^j(t) = \bar{r}(t)$ for $j \neq i$. In the monetary equilibrium we examine, lenders close to intermediaries (with low transactions costs) will hold deposits with intermediaries, while those at the farthest distances from intermediaries will hold fiat money. Intermediaries therefore do not compete directly with each other in the market for deposits in equilibrium, but they compete with their immediate neighbors in the loan market.

There will then be some lender at distance $y_1$ from intermediary $i$, who is indifferent between holding fiat money and the deposit liabilities of intermediary $i$, given $r_d(t)$. Since we will examine only stationary equilibria, we drop $t$ arguments in most of what follows. We have

\[ r_d - y_1 x_1 = p(t+1)/p(t) \quad (3) \]

That is, for the marginal lender, the rates of return on a deposit with the closest intermediary and on fiat money are equal, net of transactions costs.

Given (3) and the distribution of lenders on the unit circle from section 2, the deposit supply function faced by intermediary $i$ is

4See footnote 6, where we show how $p(t)$ responds to a change in a single firm’s decision variable.
\[ D_i = \left[ 2\alpha N / x_i \right] \left[ r^\delta_i - p(t+1)/p(t) \right] . \] (4)

Given that the intermediaries on either side and at equal distances from intermediary \( i \) set the same loan interest rate \( \hat{r}^\delta_i \), a borrower at distance \( y_2 \) from intermediary \( i \) will be indifferent between taking out a loan with intermediary \( i \) and its neighbor, where
\[ -r^\delta_i - y_2 x_2 = -\hat{r}^\delta - \frac{1}{K} - y_2 x_2 . \] (5)

Given (5), the loan demand function for the \( i \)th intermediary, given the distribution of borrowers on the unit circle from section 2, is
\[ L_i = \left[ (1-\alpha)N / x_2 K \right] \left[ (\hat{r}^\delta - r^\delta_i)K + x_2 \right] . \] (6)

The government constrains each intermediary to hold a fraction, \( \beta \), of its deposits in the form of fiat money, where \( 0 < \beta < 1 \). The \( i \)th intermediary then chooses \( r^\delta_i \) and \( r^d_i \) to maximize profits in terms of the period \( t+1 \) consumption good, subject to a balance sheet constraint and the reserve requirement. Letting \( R_i \) denote the real quantity of reserves, revenue is given by \( r^\delta_i L_i + p(t+1)R_i/p(t) \), while costs are \( r^d_i D_i \). The \( i \)th intermediary then solves
\[ \max \{ r^\delta_i L_i + p(t+1)R_i/p(t) - r^d_i D_i \} \] (7)
\[ \{ r^\delta_i, r^d_i, R_i \} \]
subject to:
\[ D_i \geq L_i + R_i + F \]
\[ R_i \geq \beta D_i \]

with \( D_i \) and \( L_i \) given by (4) and (6), respectively. We assume free entry into the intermediation industry.

**Definition:** A symmetric, zero profit, Nash equilibrium for the intermediation industry is a deposit interest rate, \( r^d \), a loan interest rate, \( r^\delta \), a deposit quantity, \( D \), a loan quantity, \( L \), a quantity of reserves, \( R \), and a quantity of intermediary firms, \( K \), such that

1. Intermediary firms maximize profits. That is, given \( \hat{r}^\delta_i = r^\delta_i \), intermediary \( i \) chooses \( R_i = R \), \( r^d_i = r^d \) and \( r^\delta_i = r^\delta \) to solve (7), \( i = 1, 2, \ldots, K \).
2. Given \( r^d_i = r^d \) and \( r^\delta_i = r^\delta \), we have \( D_i = D \) and \( L_i = L \) for \( i = 1, 2, \ldots, K \), and (4) and (6) are satisfied.
3. The number of firms, \( K \), is sufficient to drive profits to zero for each firm.

These \( K \) firms achieve equal spacing on the unit circle.5

To solve for an equilibrium, we first solve the intermediary firm's optimization problem, (7). Note that the first constraint (the balance sheet constraint) must be

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5Note that we ignore the integer constraint on the number of firms, and also ignore firms' location decisions, focussing instead on pricing decisions.
binding, since otherwise profits could be increased by reducing \( r^d \), which causes \( D \) and \( r^d D_i \) to fall, from (4). Also, the second constraint (the minimum reserve requirement) must be binding, since from (4) we have

\[
r^d = p(t+1)/p(t) + x_1 D_i / 2\alpha N > p(t+1)/p(t). 
\]

Therefore, if the minimum reserve requirement were not binding, the intermediary could reduce reserves and deposits by an equal amount, holding loans constant, and increase profits as a result.

We can then use the constraints in (7) to substitute for \( r^d \) and \( R_i \) in the objective function, obtaining a function which is concave in a single choice variable, \( r^v \).

The first-order condition for a maximum is

\[
L + [(1-\alpha) N / x_2] [-r^v + p(t+1)/p(t) + F x_i / \alpha N (1-\beta)^2 \\
+ x_i L / \alpha N (1-\beta)^2] = 0. 
\]

(8)

The zero profit condition is

\[
r^v \cdot L = [(L+F)/(1-\beta)][(1-\beta)p(t+1)/p(t) + \\
x_i (L+F)/2\alpha N (1-\beta)] = 0. 
\]

(9)

Solving (8) and (9), the unique equilibrium is given by the following:

\[
L = [(1-\alpha)F[2\alpha N (1-\beta)^2 + F x_i p(t)/p(t+1)]]/[p(t)/p(t+1)][(1-\alpha) x_1 \\
+ 2\alpha (1-\beta)^2 x_2]^{\frac{1}{2}}. 
\]

(10)

\[
D = (L+F)/(1-\beta). 
\]

(11)

\[
r^d = p(t+1)/p(t) + x_1 F / 2\alpha N (1-\beta) + x_1 L / 2\alpha N (1-\beta). 
\]

(12)

\[
r^v = p(t+1)/p(t) + x_1 F / \alpha N (1-\beta)^2 + x_1 L / \alpha N (1-\beta)^2 \\
+ x_2 L / (1-\alpha) N. 
\]

(13)

\[
K = (1-\alpha) N / L. 
\]

(14)

Note, from (10), (12) and (13), that \( p(t+1)/p(t) < r^d < r^v \), if \( F > 0 \) and \( x_1 > 0 \). That is, fiat currency is dominated in rate of return by other assets, and this rate of return dominance is explained by transactions costs and fixed costs of intermediation. Both types of costs are necessary for this result as, if \( F=0 \), then \( r^d=r^v=p(t+1)/p(t) \), and if \( x_1=x_2=0 \), then \( r^d=r^v=p(t+1)/p(t) \). With zero fixed intermediation costs, a continuum of intermediaries occupy all points on the circle, and transactions costs do not matter. Similarly, if transactions costs are zero, then all assets are perfect substitutes and must bear the same rate of return in equilibrium.
At this point we might note that the model is at odds with the observation that most consumers in developed economies hold a diversified portfolio which includes fiat currency and intermediary liabilities. Of course, as is consistent with the model, different consumers faced with the same prices hold different relative fractions of their wealth in the form of currency and intermediary liabilities. Also, consumers in the aggregate hold a diversified portfolio in our model and, since we emphasize only the model’s aggregate implications, the lack of diversification at the individual level is not important for any of the results.

4. GENERAL EQUILIBRIUM

To close the model, we need to describe how the stock of fiat money evolves over time. We assume that there is a group of agents in their second period of life at time \( t=1 \), who are collectively endowed with \( M(0) \) units of fiat money which they supply inelastically to maximize consumption. In periods \( 2, 3, \ldots, \infty \), the government increases (decreases) the stock of fiat money through lump sum transfers (taxes) to old agents. Note that these transfers or taxes do not affect savings behavior or the decisions about what assets to hold, other than indirectly through effects on the rate of return on fiat money. Transfers or taxes in each period are set so that the supply of fiat money grows at a constant gross rate, \( z \). That is,

\[
M(1) = M(0),
\]

\[
M(t+1) = zM(t), \quad t=1, 2, 3, \ldots, \infty.
\]

Letting \( q(t) \) denote the supply of fiat money in real terms \( q(t) = p(t)M(t) \), we restrict attention to the stationary monetary equilibrium, where \( q(t) \) is constant for all \( t \), so that

\[
p(t+1)/p(t) = 1/z, \quad t=1, 2, 3, \ldots, \infty.
\]  \hspace{1cm} (15)

We then obtain the stationary monetary equilibrium solution by substituting for \( p(t+1)/p(t) \) in (10)–(14) using (15).\(^6\)

\(^6\)Note that we have assumed throughout that each firm treats \( p(t) \) and \( p(t+1) \) as fixed parameters, or equivalently that \( q(t) \) and \( q(t+1) \) are fixed. To see how strong an assumption this is, we might ask how \( q(t) \) responds to a change in firm \( i \)'s deposit rate, taking the actions of other firms and \( q(t+1) \) as given. Given (4) we have

\[
q(t) = \alpha N - [K(t) - 1][2\alpha N/x_1](\tilde{r}^d - q(t+1)/q(t)z) \\
- (2\alpha N/x_1)r_i^d - q(t+1)/q(t)z.
\]

Differentiating implicitly, we get

\[
\frac{dq(t)}{dr_i^d} = -[x_1/2\alpha N + K(t)q(t+1)/q(t)^2z]^{-1}.
\]

Note that the right-hand side of the above is small if \( K(t) \) is large.
\[ L = \{(1-\alpha)F[2\alpha N(1-\beta)^2 + Fx_1 z]/z[(1-\alpha)x_1 + 2\alpha(1-\beta)^2 x_2]\}^{\frac{1}{3}}. \] \hspace{1cm} (16)

\[ D = (L+F)/(1-\beta). \] \hspace{1cm} (17)

\[ r^d = 1/z + x_1 F/(2\alpha N(1-\beta)) + x_1 L/2\alpha N(1-\beta). \] \hspace{1cm} (18)

\[ r^k = 1/z + x_1 F/\alpha N(1-\beta)^2 + x_1 L/\alpha N(1-\beta)^2 + x_2 L/(1-\alpha)N. \] \hspace{1cm} (19)

\[ K = (1-\alpha)N/L. \] \hspace{1cm} (20)

For an equilibrium of this type to exist, where some lenders hold fiat money, we must have \( KD < \alpha N \). That is, using (17) and (20),

\[ 1/L < [\alpha(1-\beta) - (1-\alpha)]/(1-\alpha)F. \] \hspace{1cm} (21)

Since \( L > 0 \), a necessary condition for an equilibrium to exist is

\[ \alpha(1-\beta) - (1-\alpha) > 0. \] \hspace{1cm} (22)

We will assume in what follows that (22) holds. Inequality (21) then implies, from (16),

\[ 1/z > F[(1-2\alpha)x_1 + 2(1-\alpha)(1-\beta)x_2]/2N(1-\beta)[\alpha(1-\beta) - (1-\alpha)]^2. \] \hspace{1cm} (23)

Therefore, given (21), there are always some feasible values of \( z \) such that the stationary monetary equilibrium exists. We assume that the right-hand side of (23) is less than unity, so that the stationary monetary equilibrium exists with moderate inflations.

It will be of interest to examine how the transactions costs incurred by agents change with parameters of the environment, and to compare these results with those obtained from other transaction cost models. For lenders, transactions costs are incurred only by the \( K(L+F)/(1-\beta) \) lenders who hold deposits. In equilibrium, the average distance of a depositor from the nearest intermediary is \( (L+F)/4(1-\beta)\alpha N \). Therefore, total transactions costs incurred by depositors are given by the function \( C_1(L) \), where

\[ C_1(L) = [(1-\alpha)x_1/4\alpha(1-\beta)^2](L + 2F + F^2/L). \] \hspace{1cm} (24)

There are two opposing effects here. As the average loan quantity of each intermediary firm falls, the number of firms increases, which tends to reduce transactions costs for those holding deposits. However, since aggregate loan demand is inelastic, an increase in the number of firms increases deposits, since deposits must finance fixed intermediation costs in addition to loans. This tends to increase total transactions costs, as marginal depositors are those with the highest transactions costs. Total transactions costs for lenders are decreasing in \( L \) for small \( L \) and increasing in \( L \) for large \( L \).
For borrowers, total transactions costs are

\[ C_2(L) = \frac{x_1 L}{4}. \quad (25) \]

Now we are ready to examine the effects of changes in \( z \), the money growth rate, and in \( \beta \), the minimum reserve ratio. In general equilibrium versions of Tobin (1956) and Baumol (1952), such as Jovanovic (1982), an increase in the inflation rate reduces average fiat money holdings for the representative consumer, nominal interest rates increase, and costs of taking trips to the bank increase. Here, increases in \( z \) increase the rate of inflation and, from (16)–(20), this results in a decrease in each intermediary firm’s loan quantity, an increase in the number of firms, and a decrease in nominal interest rates, since \( r^d \rightarrow 1/z \) and \( r^e \rightarrow 1/z \) both decrease. Therefore, from (24) and (25), transactions costs incurred by lenders may increase or decrease and borrowers’ transactions costs decrease. The dramatically different results which we get here are due to the changes in the variety of intermediation services in response to a change in the inflation rate. Since an increase in the inflation rate makes fiat money less attractive and deposits more attractive for lenders, intermediary profits increase, inducing more firms to enter the industry, thus reducing the distance between intermediary firms. Note that \( z \) affects nominal interest rates only through its effects on the distance between intermediary firms. As the number of firms increases, nominal interest rates fall.

Some of the results here are in the spirit of Tobin (1965). First, we get a “Tobin effect” in that an increase in the inflation rate leads to a decrease in real interest rates. Second, if we interpret the fixed cost of intermediation as an investment in capital which depreciates after one period, the capital stock increases with an increase in the inflation rate.

One might expect an increase in the reserve requirement to reduce the number of intermediary firms. The reserve requirement acts as a tax on intermediation, and an increase in this tax might be expected to reduce intermediary profits and cause exit from the industry. However, this may not be the case. We have

\[ \frac{\partial L}{\partial \beta} = \frac{2(1-\beta)(1-\alpha)\alpha F x_1 [F x_2 z - (1-\alpha)N]}{z L ((-\alpha) x_1 + 2\alpha (1-\beta)^2 x_2)^2} \geq 0, \]

so that the number of intermediary firms may increase or decrease as \( \beta \) increases. There are two effects which come into play here. First, a given quantity of loans costs more to “produce” with a higher reserve requirement, since more deposits must be attracted with a higher interest rate on all deposits, and more of these deposits are held at a loss in the form of reserves. This effect tends to discourage entry. Second, profit maximization implies that firms will set higher loan rates with a larger reserve requirement. This tends to increase profits and to encourage entry.

There are some unambiguous effects of increases in reserve requirements.
Nominal interest rates increase, and the deposit liabilities of each intermediary firm increase, from (16)–(19).

5. WELFARE

As a welfare measure for this population of heterogeneous agents, we use the sum of utilities across agents in a representative generation, ignoring agents who are old at time \( t = 1 \). Letting \( W \) denote this sum of utilities, we obtain

\[
W = (1-\alpha)Ny + 2\alpha N - N - (1-\alpha)NF/L - C_1(L) - C_2(L),
\]

where \((1-\alpha)Ny\) is the total endowment of borrowers in the second period of life, \(2\alpha N\) is the total endowment of lenders in the first period of life, \(N\) is the consumption of young agents, \((1-\alpha)NF/L\) are fixed costs of intermediation, and \(C_1(L)\) and \(C_2(L)\) are transactions costs incurred by borrowers and lenders, respectively. Maximizing welfare is then equivalent to minimizing fixed intermediation costs plus transactions costs, which we can express as a function of \( L \), using (24) and (25):

\[
C(L) = (1-\alpha)NF/L + (1-\alpha)x_1 L/4\alpha(1-\beta)^2 + (1-\alpha)x_1 F/2\alpha(1-\beta)^2 \\
+ (1-\alpha)F^2 x_1/4\alpha(1-\beta)^2 L + x_2 L/4. \tag{26}
\]

Choosing \( L \) to minimize \( C(L) \), we obtain the optimal loan quantity for each firm, denoted \( L^* \), which implies an optimal number of intermediary firms. We have:

\[
L^* = \{(1-\alpha)F[4\alpha(1-\beta)^2 N + Fx_1]/[(1-\alpha)x_1 + \alpha(1-\beta)^2 x_2]\}^{1/2}. \tag{27}
\]

Now, taking \( \beta \) as given, we can find the optimal money growth rate, \( z^* \), which yields \( L = L^* \) in equilibrium. From (16) and (27), we get

\[
[4\alpha(1-\beta)^2 N + Fx_1]/[(1-\alpha)x_1 + \alpha(1-\beta)^2 x_2] \\
= [2\alpha N(1-\beta)^2 + Fx_1 z^*]/z^*[(1-\alpha)x_1 + 2\alpha(1-\beta)^2 x_2].
\]

Solving for \( z^* \) gives

\[
z^* = \frac{2N[(1-\alpha)x_1 + \alpha(1-\beta)^2 x_2]}{4N[(1-\alpha)x_1 + 2\alpha(1-\beta)^2 x_2] + Fx_1 x_2}.
\]

Note that \( z^* < 1 \), so that deflation is optimal no matter what the minimum reserve requirement is. Since the equilibrium number of intermediary firms is increasing in \( z \), from (16) and (20), there are then too many firms in a laissez faire equilibrium with a fixed supply of fiat money \((z=1)\). Note that we obtain a wel-
fare improvement in moving from laissez faire to the optimum in spite of the fact
that nominal interest rates increase, transactions costs incurred by borrowers
increase, and transactions costs incurred by lenders may increase.

Sidrauski (1967) provides a formal model of the world underlying Friedman's
(1969) essay on the optimum quantity of money, in which deflation at the rate of
time preference is optimal. In this model, deflation acts to equate real rates of
return on money and alternative assets, rather than creating a divergence, as is
the case here. Jovanovic (1982) also obtains the Friedman rule in a model with
transactions costs, but in his framework deflation reduces transactions costs by
decreasing the frequency of trips to the bank. In our model "trips to the bank"
decrease with deflation, as inelastic loan demand implies that borrowers always
take the same number of trips, and with a fewer number of intermediary firms
there are fewer depositors. However, since the distance between firms increases
as the number of firms decreases, each trip is more costly.

Note that the result that there are too many firms in a laissez faire equilibrium
is almost certainly not robust. It is well known in the industrial organization
literature that different models of imperfect competition generate different re-
results in this respect. The monopolistic competition models of Dixit and Stiglitz
(1977) and Spence (1976) tend to predict that there will be fewer firms with free
entry than at the social optimum, while in the homogeneous product models of
von Weizsacker (1980) and Perry (1984) there is a tendency for too much entry.
On the other hand, Koenker and Perry (1981) show that too much entry can be
the result in Dixit and Stiglitz-type models, if different conjectural assumptions
are made. Also, there is a tendency for fewer firms (than in a zero profit equilib-
rium) in equilibrium in spatial competition models such as Prescott and Visscher
(1977), Hay (1976), and Schmalensee (1978), where incumbent firms act to deter
entry. Our result of too much entry is consistent with what we would obtain in a
similar one-dimensional location model with a single produced product and in-
elastic demands. Mankiw and Whinston (1986) point to two factors at play here:
a "business stealing" effect, which encourages excessive entry, and an externality
effect where entering firms do not internalize the benefits of increased product
diversity. Due to the fact that loan demand is inelastic in our model, the first
effect dominates here.

While we should not take the optimal deflation result in this model too se-
riously, this example is intended to show that taking fixed intermediation costs
into account matters. By including these fixed costs, we can get results which are
radically different from those obtained in other models of money with transac-
tions costs.

6. CONCLUSIONS

If we are to take seriously the interpretation of transactions costs as "trips to
the bank" in Tobin-Baumol models of money demand, we must also take fixed
costs of financial intermediation seriously. In this paper, a model with fixed in-
intermediation costs and costs of transacting with intermediaries was constructed, which has implications which are quite different from those of general equilibrium Tobin-Baumol-type models, such as Jovanovic (1982). Thus, ignoring fixed intermediation costs is not innocuous.

Our model is a simple, tractable model of imperfectly competitive financial intermediaries, embedded in an overlapping generations framework. An increase in the inflation rate brought about by an increase in the fiat money growth rate results in a decrease in equilibrium nominal interest rates and an increase in the variety of financial intermediation services. It may be the case that transactions costs incurred by all agents decrease. Deflation is optimal, since there is an excessive variety of intermediation services in a laissez faire equilibrium with zero inflation. An increase in the minimum reserve requirement faced by intermediary firms acts as a tax on intermediation, but an increase in this tax may cause an increase or a decrease in the number of firms in equilibrium.

The fact that deflation in this model is optimal is not likely to be robust. However, in the realm of imperfectly competitive models, there are few results, if any, which are robust. Also, at the least, this model shows the channels through which welfare is affected by inflation and reserve requirements if the intermediation industry is imperfectly competitive, and if there are costs of transacting with these intermediaries.

LITERATURE CITED


