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Implications of Banking Market Structure for Monetary Policy: A Survey

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Abstract

This paper presents a survey of the analytical literature on bank behavior in imperfect markets, focusing on the implications for monetary policy. While the literature on bank behavior under different competitive conditions is extensive, there are only a few models that incorporate the banking industry features into a macroeconomic and monetary policy framework. A review of these models reveals that the effect of the competitive conditions in the banking markets for monetary control seems to depend not only on the type of operating targets and instruments used for implementing monetary policy, but also on the specific structure of the model.

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Summary

This paper presents a survey of the analytical literature on bank behavior in imperfect markets, focusing on the implications for monetary policy. To this end, the author first presents a simple model of a monopolist bank, which is then extended to discuss the literature dealing with bank behavior under a variety of assumptions that reflect the special regulatory and environmental features of the banking industry. Against this background, the author reviews the emerging literature on the consequences for monetary policy of monopolistic bank behavior, discussing four major articles.

While the literature on bank behavior under different competitive conditions is extensive, there are only a few models that incorporate the banking industry's features into a macroeconomic and monetary policy framework. Some of the implications for monetary policy discussed in this emerging literature are as follows. First, the reduction in reserve requirements in a liberal system, or a relaxation of ceilings on deposit interest rates would unambiguously increase these rates and, therefore, the volume of deposits irrespective of the banking market structure. However, in a monopolistic market, these policies could have an ambiguous effect on the loan interest rate and, therefore, on the volume of loans, although they serve to raise loan rates under competitive conditions, Second, a greater degree of competition in the deposit market would increase the volume of deposits, but would have a complex and ambiguous impact on the government's ability to control a monetary aggregate. Moreover, the effect of competition on monetary control seems to depend not only on the type of operating targets and instruments used for monetary policy, but also on the specific structure of the model. These findings suggest considerable further research remains to be done before firm conclusions could be reached on the impact of liberalization policies for monetary policy under alternative bank market structures.

I. Introduction

Banking and capital market imperfections are in a certain sense two inseparable issues. The very existence of a financial intermediation sector, that absorbs an appreciable amount of resources, is due to special imperfections in some sections of the capital market. Indeed, the function of financial institutions is to exploit imperfections like transaction costs or incomplete information in the exchange of capital claims.

The relationship between the degree of competitive behavior of financial institutions, and the imperfections that generate the need for financial intermediation, is still a controversial issue. Pringle (1973, 1974a) suggests that these imperfections imply a certain degree of market power by banks. 1/ He argues that the very nature of the banking business segments the market, so that each bank is not a price taker in some of the services that it offers. Baltensperger (1980) has challenged this view, noting that "markets featuring these elements can be atomistic markets characterized by a high degree of competition." 2/

This paper will survey the analytical 3/ literature on banking markets characterized as imperfect in the specific sense that banks have market power and are not price takers. This market power in banking can be traced back to two factors. First, the nature of banking business itself may lead to segmented markets in which only very few banks service each group of customers. Second, banking is extremely concentrated in most geographical areas, and legal barriers to entry are pervasive. These two factors lead to market structures that imply some monopoly power. Of these, literature has discussed the cases of monopoly, monopolistic competition, and oligopoly. In the first case, there is only one bank or a perfectly colluding group of banks. In the second case, there are several price-setter banks but without strategic interaction among them. Finally, in the third case, there are a certain number of banks which take into account how their actions affect the behavior of other banks.

The major purpose of this survey is to highlight how certain key variables such as loan rates, deposit rates, excess reserves, and volume of loans and deposits, are affected by the structure of the banking sector and thereby elucidate the impact of banking structure on the effectiveness of monetary policy. The importance of such analysis lies in the fact that it may help in understanding the

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1/ Pringle (1973), p. 995 and Pringle (1974b), pp. 780-81.

2/ Baltensperger (1980), p. 24.

3/ The empirical literature that deals with the relationship between market structure and performance in banking will not be reviewed in this paper. There are several surveys on this topic that the interested reader may consult: Rhoades (1977, 1982), Heggestad (1979), and Spellman (1982).

likely consequences of financial sector liberalization for the behavior of key variables, and hence for the effectiveness of monetary policy following a liberalization.

The structure of the paper is as follows: Section II surveys the theory of monopolistic bank behavior with particular emphasis on the implications of such behavior for monetary policy and interest rate determination. Section III reviews some articles that focus on the consequences of a monopolistic banking sector for monetary policy. Finally, Section IV summarizes the likely consequences of financial liberalization for monetary policy when the banking market structure is monopolistic.

II. Behavior of a Banking Firm with Market Power

The theory of monopolistic bank behavior is a particular case of the theory of a multiproduct firm which faces interdependent markets for its products. From the perspective of monetary policy, the two main banking products may be conceptualized as loans and deposits. The focus of this section is to stress how the markets for these two products operate and are linked in a situation of monopoly.

The organization of this section is to set out a simple model and then to introduce further developments one at a time. Subsection II.1 describes the workings of the simple model. In this case, the monopolistic bank can borrow or lend freely in a competitive portion of the capital or money market (called securities market in this paper), and the loan and deposit sides of banking are completely independent. Subsection II.2 deals with the opposite polar case: the securities market does not exist, which constrains the amount of loans to the amount of deposits attracted.

Subsections II.3 to II.7 introduce the three basic linkages between loans and deposits--joint economies in real resources, demand interdependence, and financial liquidity. Subsection II.3 incorporates the real cost of servicing a certain amount of loans and deposits. Subsection II.4 complicates the previous setup by introducing the possibility of fees for the services provided. Subsection II.5 studies a particular case of interdependence between the loan and deposit demand function: the bank retains as deposits a certain proportion of the loans that it offers. Subsection II.6 deals with soundness and liquidity considerations in the form of financial constraints between particular assets and liabilities held by the bank. Finally, subsection II.7 explains the holdings of excess reserves, and other liquid assets, introducing adjustment costs and stochastic amount of deposits.

Subsection II.8 to II.11 generalize the basic model in four different directions. Subsection II.8 introduces uncertainty in asset returns and risk aversion. Subsection II.9 studies the consequences of the bank being able to discriminate among borrowers. Subsection II.10 opens the possibility of using the amount of equity as a decision variable. Finally, subsection II.11 sets the behavior of the bank in a multi-period context.

1. Basic model

This section builds a very simple model of the behavior of a monopolistic bank. The model will be used later as a framework to develop the different aspects dealt with in the literature.

Its main assumptions are:

a. The bank has two liabilities--equity capital and deposits, and three assets: loans, required reserves and securities.

b. Equity capital is given exogenously.

c. Deposits are aggregated in only one category. Furthermore, they are an increasing function of the deposit interest rate.

d. Loans are considered homogeneous. The demand for loans that the bank faces is a decreasing function of its lending rate.

e. Required reserves are a given proportion of deposits and yield an exogenously fixed interest rate. For simplicity, this interest rate is assumed to be zero.

f. Securities can be bought and sold at an exogenously given interest rate, i.e., the bank is a price taker in the securities market. The net amount of securities held by a bank can be either positive or negative.

g. The objective of the bank is to maximize profits.

This model abstracts from most of the special characteristics of a banking firm that are considered in subsequent subsections. Indeed, it disregards real costs of banking services, liquidity costs, soundness constraints, retention of deposits, discrimination among customers, risk and uncertainty.

The bank's objective is to choose deposit and lending rates (r_D, r_L) in order to maximize profits (Π) expressed as:

$$\Pi = r_L L + r_S S - r_D D \tag{1}$$

subject to the following constraints:

$$L + S + R = E + D \text{ (bank balance sheet);} \tag{2}$$

$L = L(r_L)$ (demand for loans), $L' < 0$; (3)

$D = d(r_D)$ (demand for deposits), $d' > 0$; (4)

and $R = kD$ (definition of required reserves; excess reserves are assumed to be always zero); (5)

where Π = profits

L = loans

S = securities

D = deposits

R = required reserves

E = equity capital

r_L = interest rate yielded by loans

r_D = interest rate paid on deposits

r_S = securities interest rate

k = proportion of deposits to be held as required reserves

L = functional form of the demand for loans

d = functional form of the demand for deposits

$'$ = the first derivative of a function.

The solution to this problem 1/ may be characterized by an algebraic transformation of the first order conditions as follows:

$$r_L(1 + \frac{1}{\varepsilon_L}) = r_S = \frac{r_D}{1 - k}(1 + \frac{1}{\varepsilon_D}); \qquad (6)$$

where ε_L = elasticity of the loan demand function; and

ε_D = elasticity of the deposit demand function.

In the optimum, the bank will equate the marginal revenue from any asset with the marginal cost of obtaining funds from any source.

1/ Throughout this paper the second order conditions are assumed to hold, and the solutions are assumed to be interior.

Since the bank can invest or borrow funds at the interest rate r_S, marginal revenue and marginal cost of funds must equal r_S.

The generalization of this model for the case of n kinds of loans (or investments) and m kinds of deposits is straightforward. If the loan demand and deposit supply functions depend only on their own interest rates, 1/ the characterization of the solution is still the same, except for the sub-indices labelling the types of loans or deposits:

$$r_{Li}(1 + \frac{1}{\varepsilon_{Li}}) = r_S = \frac{r_{Dj}}{1 - k_j}(1 + \frac{1}{\varepsilon_{Dj}}), \; i = 1...n, \; j = 1...m. \qquad (7)$$

The most important implication of this model is that the amount of loans and deposits will be unequivocally smaller than in perfect competition. This is just the standard result of the textbook monopoly model. The monopolistic bank can obtain extra profits by setting r_L higher and r_D lower than the competitive outcome, thus reducing the size of financial intermediation.

Another interesting feature is the dichotomy between the asset and liability sides of bank operations, i.e., the loan interest rate is completely independent of the deposit interest rate and legal reserve requirements. This characteristic is stressed by Klein 2/ in a slightly more complicated model. Pringle 3/ dismissed the practical importance of this result, arguing that it requires highly stringent assumptions. As will be seen below, the key assumptions for this result are the existence of a securities market in which the bank is a price taker, the abstraction from real costs of banking which precludes joint economies, and the independence between the loan and deposit demand functions. 4/

1/ This assumption is theoretically unsatisfactory since optimization behavior by the individuals would yield supply and demand functions that depend on all the interest rates (see Brainard and Tobin, 1968). However, because of its simplicity, it is widely used in the literature.

2/ Klein (1971), pp. 214-15.

3/ Pringle (1973).

4/ Pringle (1973) specifies a list of five key assumptions that lead to Klein's dichotomy result:

"1. Risk neutrality on the part of banks' shareholders;
2. A downward-sloping demand curve for loan funds;
3. Upward-sloping supply curves of deposits, *unconstrained* as to minimum or maximum rates;
4. A perfectly elastic supply of U.S. government securities (i.e., the bank can invest without limit in government securities at a given [exogenous] rate); and
5. A single decision period, with the maturity of loans and deposits equal to the length of that period." (p. 990).

This list is quite misleading since it ignores the dependence of the loans and deposits functions on only their own rates, and stresses non-essential points. Assumptions 2 and 3 are important only to ensure the

(continued)

Monti (1971, 1972), Slovin and Sushka (1975) 1/, and Van Loo (1980) develop simple extensions to the model presented above. They incorporate features such as the introduction of the securities interest rate in the loan and deposit demand functions, which yields a richer set of comparative static results. In particular, they discuss bank behavior with alternative objective functions, like maximizing the volume of deposits subject to the realization of a minimum amount of profits. They suggest that a bank may sacrifice its profits in order to increase its size. In general, the more weight the bank gives to size the closer it gets to the perfect competition solution (provided that negative profits are ruled out). 2/

2. Nonexistence of the securities market

In some less developed countries the assumption that the bank can borrow or invest in a competitive sector of the capital or money market (called securities in the basic model) may be totally inappropriate. If a securities market is absent, then the solution is characterized by:

$$r_L(1 + \frac{1}{\varepsilon_L}) = \frac{r_D}{1 - k}(1 + \frac{1}{\varepsilon_D}). \qquad (8)$$

In contrast to the basic model, the loan and deposit interest rates are now closely related.

Note, however, that if r_D is fixed exogenously, for instance by the monetary authorities, r_L is no longer determined by the above equation, but is given by the condition:

$$L = E + \frac{1}{1 - k} D ; \qquad (9)$$

which is simply the balance sheet constraint. In this case, a reduction in r_D will decrease D; L will have to decrease also, and consequently r_L will be raised. Therefore, r_L depends inversely on r_D, which is a paradoxical result.

Footnote 4/ (continued)
existence of an interior solution. Indeed, the dichotomy result is not affected in any interior solution if 2 and 3 are missing. Assumptions 1 and 5 are important, but could be replaced with a generalization of 4 in the context of risk and multiperiod horizon. For example, the existence of a contingent set of securities markets for each period, in which the bank is a pricetaker.

1/ The model developed by Slovin and Sushka (1975) is only concerned with the deposit side, and applies mainly to savings institutions. They apply their model to analyze the savings institutions of different countries.

2/ Van Loo develops his model in other directions that will be reviewed in later subsections.

Goldfeld and Jaffee (1970) develop another model where banks do not have the ability to borrow and invest in a securities market. This model will be discussed in Section II.11, dealing with intertemporal features.

3. Real costs of banking services

The use of real resources in the production of banking services can be introduced by assuming a well behaved (convex and twice differentiable) cost function for managing a certain volume of deposits and loans. This approach bypasses all the complexities and peculiarities of the production of banking services. 1/

In this case, the optimization problem for the banking firm can be expressed as:

$$\max_{(r_L,\ r_D)} \ \Pi = r_L L + r_S S - r_D D - C(L,\ D); \qquad (10)$$

where C(L, D) is the cost in real resources corresponding to specific levels of deposits and loans.

The first order conditions of the optimum become:

$$r_L\left(1 + \frac{1}{\varepsilon_L}\right) - \frac{\partial C}{\partial L} = r_S = \frac{1}{1 - k}\left[r_D\left(1 + \frac{1}{\varepsilon_D}\right) + \frac{\partial C}{\partial D}\right] . \qquad (11)$$

The interpretation of these two equalities is still the same as in the basic model, but now the marginal revenue from loans has to be taken net of the marginal cost in real resources of maintaining those loans, while the marginal cost of deposits has to include both the financial and the real cost. It is important to note that the independence of r_L and r_D implicit in the above first order condition will no longer hold if the cross derivative of the cost function is not zero. Intuitively, the bank may have joint economies in servicing loans and deposits, so that the pricing of loans is not independent of the amount of deposits attracted and vice versa.

Sealey and Lindley (1977) develop a model based on the framework presented above. Their main concern, however, is not the implications of the market power the firms may have, but how a meaningful production function could be introduced in the theory of banking. VanHoose (1983) develops a much more comprehensive model, using the same framework. This model will be reviewed in some detail in Section III.

1/ For a derivation of this cost function from the technical aspects of banking, see, for example, Pesek (1976), Sealey and Lindley (1977) and Elyasiani (1983).

4. Real costs and service fees

Banks choose varied ways to provide services to deposit holders and to charge for these services. Some bank services may vary in proportion to the amount of deposits that customers have. For other services, banks establish a certain price for the service and provide the amount demanded at that price, e.g., check clearing. Also, it is common practice to follow more complex rules, like providing a service free of charge under certain conditions; e.g., free checking privileges if the customer holds a minimum deposit. Any of these cases result in different formal models. This survey presents a simple case and comments on other treatments that have appeared in the literature. In the simple model, the bank sets a price for a service, and provides the amount demanded. In addition, the demand for deposits is sensitive not only to the deposit interest rate, but also to the price that the bank charges for related services.

The maximizing problem for the bank is:

$$\max_{(r_L,\ r_D,\ a)} \quad \Pi = r_L L + r_S S + aZ - r_D D - C(L,\ Z,\ D) \tag{12}$$

$$\text{subject to: } L + S = (1 - k)D + E \text{ (bank balance sheet)} \tag{13}$$

$$L = L(r_L) \text{ (demand for loans)} \tag{14}$$

$$D = D(r_D,\ a) \text{ (demand for deposits)},\ \partial D/\partial a < 0 \tag{15}$$

$$Z = Z(a) \text{ (demand for services)},\ Z' < 0\ , \tag{16}$$

where Z is the amount of services provided, and a the price charged for them.

The first order conditions imply:

$$r_L(1 + \frac{1}{\varepsilon_L}) - \frac{\partial C}{\partial L} = r_S = \frac{1}{1 - k}\left[r_D(1 + \frac{1}{\varepsilon_D}) + \frac{\partial C}{\partial D}\right] \tag{17}$$

and

$$r_D + (\partial D/\partial a)^{-1} Z' \left[\frac{\partial C}{\partial Z} - a(1 + \frac{1}{\varepsilon_a})\right] = r_D(1 + \frac{1}{\varepsilon_D}) \tag{18}$$

where ε_a is the elasticity of Z with respect to a. The interpretation of the first condition is the same as in the previous section. The expression in brackets in the second equation may be interpreted as the marginal net cost of providing the service Z. Therefore, the second condition means that the marginal cost of attracting deposits with a higher deposit interest rate (right-hand side) should be equal to the marginal cost of attracting deposits with a lower service charge (left-hand side).

It is interesting to note that if markets are competitive (ε_D and ε_a tend to infinity), the last condition for an optimum implies:

$$\frac{\partial C}{\partial Z} = a \ , \tag{19}$$

i.e., the marginal cost of providing a service should be equal to its price. In this model, banks subsidize some services only when they have monopoly power.

If the deposit interest rate is exogenous, the first order conditions will be:

$$r_L(1 + \frac{1}{\varepsilon_L}) - \frac{\partial C}{\partial L} = r_S \ ; \text{ and} \tag{20}$$

$$r_D + \frac{\partial C}{\partial D} + \left(\frac{\partial D}{\partial a}\right)^{-1} Z' \left[\frac{\partial C}{\partial Z} - a(1 + \frac{1}{\varepsilon_a})\right] = r_S(1 - k) \ . \tag{21}$$

Note that a decrease in r_D will increase the net marginal subsidy in the provision of services by the bank. In other words, the bank will use the provision of subsidized services as a substitute for r_D to attract deposits.

Elyasiani (1983) builds a model where the service provided by banks is check clearance. Banks have market power in providing this service, but not in the loan and deposit markets. In addition, the demand for check clearance depends positively on the amount of bank deposits, which is treated as exogenous. Elyasiani's model also contains other elements, like uncertainty in some variables and risk aversion. However, the main results relating to the provision of services are the same as in the basic model presented above.

Towey (1974) generalizes this model for a number of services, free or subject to a charge. However, he constrains the services that the bank provides to be proportional to the amount of deposits, and builds a model of monopolistic competition. He discusses later how the theory of the money multiplier can be derived from this theory of the banking firm. However, this derivation is not based on monopolistic elements of his model, but relies on the long-run equilibrium condition that profits are zero.

A different perspective on bank service charges is given by Startz (1983). He conceptualizes the difference between the cost of the bank services and the service fee as an implicit form of paying interest on deposits. The demand for deposits depends, then, on both the implicit and the explicit interest rate. He solves for the optimum policy of banks in a Chamberlinian monopolistic model, and discusses the effects of explicit interest rate ceilings. This article is discussed further in Section III of this paper.

5. Retention of deposits

The preceding models have assumed that the bank is a monopolist only in the sense that it faces downward sloping demand curves for loans and deposits. This assumption is reasonable for a bank which is small relative to the economy, but with a certain local market power. However, there is still another possible source of market power: a positive redeposit rate. Indeed, if the bank or group of colluding banks is the only one in the economy, it will be able to retain as deposits a certain proportion of the funds it lends.

The ability of the bank to retain deposits may be incorporated in the formulation of the optimization problem by assuming that the demand for deposits depends positively on the volume of loans, i.e.,

$$D = d(r_D, L) \text{ (with } \partial D/\partial L > 0) \tag{22}$$

The first order conditions now become:

$$r_L(1 + \frac{1}{\varepsilon_L}) + \frac{\partial D}{\partial L}[r_S(1 - k) - r_D] = r_S = \frac{r_D}{1 - k}(1 + \frac{1}{\varepsilon_D}) \tag{23}$$

The marginal revenue of a loan will have two elements: the direct and the indirect one. The direct element is just $r_L(1 + 1/\varepsilon_L)$as before. The indirect element is $\partial D/\partial L[r_S(1 - k) - r_D]$, and comes from the interaction between loans and deposits. If the bank has market power, this term will be strictly positive. However, the term will vanish in perfect competition since then $r_S(1 - k) = r_D$.

The existence of a positive redeposit rate will tend to offset the normal contractionary effect of monopoly power on the volume of loans. Indeed, the amount of loans may be even larger than in perfect competition. If the degree of monopoly in deposits is high enough--r_D is low compared to $r_S(1 - k)$--the bank may be interested in lending at a lower rate than in the securities market to increase the volume of deposits. Another interesting point is the fact that the interest rates on loans and deposits are no longer independent of each other. The dependence of the demand for deposits on the amount of loans breaks down the separation between the two markets, despite the existence of the securities markets that facilitate liability management.

In the literature, the retention of deposits has been treated in Aftalion and White (1977) and Tobin (1982), who use models similar to the one presented above. Slovin and Sushka (1983) study a related topic, namely the requirement of compensating balances. However, their model is different because they assume that the compensating balances do not receive the deposit interest rate but an exogenous rate (zero). This policy would be equivalent to charging a higher loan rate. With zero reserve requirements it will represent only a formal change; but with positive reserve requirements the bank will incur an extra cost when pursuing this policy.

6. Soundness and liquidity constraints

One of the essential characteristics of banking is liquidity and risk management. Banks not only face uncertain returns on their assets, which is a common feature of all portfolio holders, but they transform short-term liabilities into longer-term assets. One approach to dealing with these matters is to treat the sources of uncertainty--e.g., asset return, rate of default or volume of deposits--as stochastic variables. This approach will be analyzed in subsequent sections. Here, soundness and liquidity will be introduced as certain constraints on the balance sheet of banks. This alternative approach seems to be particularly relevant when there are binding regulations on such matters.

A common liquidity constraint is that the amount of securities, which can be seen as secondary reserves, has to be greater than or equal to a certain proportion of deposits. The problem of the bank is then:

$$\max_{(r_L,\ r_D)} \quad \Pi = r_L L + r_S S - r_D D \tag{24}$$

subject to: $L + S + R = E + D$ (bank balance sheet) (25)

$L = L(r_L)$ (demand for loans) (26)

$D = D(r_D)$ (demand for deposits) (27)

$R = kD$ (required reserves definition) (28)

$S \geq hD$ (liquidity constraint) (29)

where h is the minimum proportion to be held in securities.

If the liquidity constraint is not binding, the solution to this problem is identical to the basic model of subsection II.1. If the liquidity constraint is binding, the first order conditions imply:

$$r_L\left(1 + \frac{1}{\varepsilon_L}\right) = r_S + \lambda \tag{30}$$

$$r_D\left(1 + \frac{1}{\varepsilon_D}\right) = r_S(1 - k) + \lambda(1 - k - h) \tag{31}$$

where λ is the Lagrange multiplier. The marginal value of holding securities is not only r_S, but includes the shadow value implied by the liquidity constraint as well. Using the two equalities above to eliminate λ, we obtain the equation that relates r_L with r_D, which are not independent in this case,

$$r_L(1 + \frac{1}{\varepsilon_L})(1 - k - h) + r_S h = r_D(1 + \frac{1}{\varepsilon_D}) \qquad (32)$$

The right-hand side of this equality is the marginal cost of obtaining funds through deposits. The left-hand side is the marginal revenue that can be obtained from them, expressed as a weighted average of the marginal returns of each investment, where the weights are the proportions that have to be invested in each asset.

Slovin and Sushka (1983) develop a model incorporating a simple liquid asset requirement as outlined above. Mingo and Wolkowitz (1977) and Van Loo (1980) study a more general "soundness" constraint. In these models, a soundness index is defined as a weighted sum of various assets and liabilities of the bank. The weights assigned to different assets are positive; the more liquid the asset, the larger is its weight. The weights for liabilities are negative; the greater the ease of withdrawal, the greater the weight. The soundness index so constructed is constrained to be greater than or equal to a certain amount. 1/ This more general constraint has the same economic implication as the simpler liquid asset requirement discussed above: when the constraint is binding, liquid assets and stable liabilities--i.e., those with larger weights--become relatively more valuable to the bank and this would be reflected in the prevailing interest rate differentials.

7. Stochastic amount of deposits

Holdings of excess reserves are explained in the literature in terms of two features: a stochastic amount of deposits, and a penalty cost when the amount of reserves falls below the required level. In the model below, taken from Klein (1971), banks allocate funds among assets before knowing with certainty the amount of deposits. Once the amount of deposits is realized, banks face a penalty cost of adjustment to meet the reserve requirement. The penalty cost is assumed to be proportional to the reserve deficiency. Therefore, the penalty cost (P) will be:

$$P = p[Dk - (R + ER)] , \qquad \text{if } ER < 0 \quad \text{and} \qquad (32a)$$

$$P = 0 \qquad , \qquad \text{if } ER \geq 0 . \qquad (32b)$$

where p is the penalty cost to adjust one unit of reserves, and ER is

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1/ The liquidity constraint used by Slovin and Sushka is a special case of this general soundness constraint where the weights are:

Loans	0
Required reserves	0
Securities	1
Deposits	-h
Equity capital	0

and the minimum soundness index value is 0.

the amount of ex-post excess reserves. Using the balance sheet identity we have:

$$P = p[Dk - (D + E - L - S] , \quad \text{if } D < \frac{L + S - E}{1 - k} \quad \text{and} \tag{33a}$$

$$P = 0 , \quad \text{if } D > \frac{L + S - E}{1 - k} . \tag{33b}$$

The problem of the bank is:

$$\max_{(r_L, r_S, S)} \quad r_L L + r_S S - r_D D - \overline{P} \tag{33}$$

where $\overline{P}$ = expected penalty; subject to:

$$L = L\,(r_L) \quad \text{(demand for loans)} \tag{34}$$

$$D = D(r_D) - X \quad \text{(demand for deposits); X is a random variable .} \tag{35}$$

The expected penalty can be written as:

$$\overline{P} = \int_{\hat{X}}^{\infty} p[Dk - (D + E - L - S)]f(X)dX \tag{36}$$

where $\hat{X}$ is the realized value of X when the amount of excess reserves is zero, given by:

$$\hat{X} = \frac{L + S - E}{1 - k} - D(r_D) \tag{37}$$

Observe that the level of ex-post excess reserves is:

$$ER = (1 - k)(\hat{X} - X).$$

The first order conditions for an optimum imply:

$$r_L(1 + 1/\varepsilon_L) = r_S \tag{38}$$

$$r_D(1 + 1/\varepsilon_D) = r_S(1 - k) \quad \text{and} \tag{39}$$

$$p \int_{\hat{X}}^{\infty} f(X)d\hat{X} = r_S . \tag{40}$$

The first and second equations are just the same as in the basic model of subsection II.1. The third equation may be interpreted as the equality in the optimum between the marginal revenue of investing funds in earning assets and the marginal expected penalty cost of adjustment of reserves. The existence of a perfectly competitive securities market 1/ separates not only the loan and deposit sides of banking, but also the precautionary excess reserve holdings, i.e., there is no interaction between the market power the bank has and the liquidity costs. This model leads to the standard result that an increase in the security rate, r_S, will lead to a reduction in excess reserves (reduce $\hat{X}$ and, hence, ER), since the cost of avoiding the expected penalty is higher.

Tobin (1982) deals with the holdings of secondary reserves in the form of securities, abstracting from the holdings of excess primary reserves. Securities are assumed to not be traded in a competitive market, but the bank faces different returns for holding positive and negative amounts of securities. If the bank invests in securities, it obtains a return r_S. If the bank issues securities, has to pay a proportional yield $r_S + b$, plus a fixed amount, c (b and c are positive). In other words, the bank is penalized for being a net borrower in the securities market.

A slightly simplified version of Tobin's model can be formulated as follows:

$$\max_{(r_L,\, r_D)} \quad \text{expected } \Pi$$

$$\Pi = r_L L + r_S S - r_D D \qquad \text{if } S \geq 0 \tag{41a}$$

$$\Pi = r_L L + (r_S + b)S - r_D D - c \qquad \text{if } S < 0 \tag{41b}$$

subject to

$$L + S + R = D + E \text{ (bank balance sheet)} \tag{44}$$

$$L = L(r_L) \text{ (demand for loans)} \tag{45}$$

$$D = D(r_D) + X \text{ (demand for deposits); 2/} \tag{46}$$

$$R = kD \text{ (definition of required reserves)} \tag{47}$$

where X is again a stochastic component of deposits.

The characterization of the optimum from the first order conditions imply:

$$r_L\left(1 + \frac{1}{\varepsilon_L}\right) = r_S + bF(x^*) + \frac{c}{1 - k} f(x^*) = r_S^* \tag{48}$$

1/ To be more precise, the securities market is perfectly competitive in the "a priori" stage (before knowing the realization of X), but not in the "a posteriori" stage.

2/ In Tobin (1982) the demand for deposits is $D = D(r_D)(1 + X)$; i.e., the stochastic term is proportional to $D(r_D)$. Tobin's assumption seems more plausible, but complicates the algebra.

$$\frac{r_D}{1-k}\left(1+\frac{1}{\varepsilon_D}\right) = r_S + bF(x^*) + \frac{c}{1-k} f(x^*) = r_S^* ; \tag{49}$$

where F is the distribution function of X, and x* is the critical realized value of X such that S = 0. Using the balance sheet constraint,

$$x^* = \frac{L - E}{1 - k} - D(r_D) \tag{50}$$

In the optimum, the marginal revenue from loans will be equal to the marginal cost of obtaining disposable funds from deposits, and both will be equal to the expected marginal value of holding securities. The parallelism between these conditions and those in the basic model of subsection II.1 is more apparent than real. At first sight, r_S is only replaced by r_S^* which takes into account the expected penalty cost. However, r_S^* is no longer an exogenous variable for the bank: r_S^* depends on x*, which depends on the amount of loans relative to the amount of expected deposits. Therefore, the loan and deposit sides of banking are interconnected through r_S^*. Intuitively, the bank will reduce the amount of loans and increase the amount of deposits in order to reduce the expected penalty cost of borrowing.

8. Risk aversion and uncertainty returns

The models surveyed so far have abstracted from risk aversion and uncertainty of asset returns. This approach could be defended, arguing that the interest rates yielded by loans or securities should be viewed as the certainty equivalents of the real world returns. However, this implicitly assumes that risk premia are independent of the monopolistic bank behavior, and that either investors are risk neutral, or the resulting profits are stochastically independent of the "market" portfolio return. The articles summarized below drop this strong assumption.

Pringle (1974a) develops a model similar to the one analyzed in Tobin (1982), but in the context of the mean-variance asset-pricing framework. In this model the monopolistic bank faces a penalty rate for borrowing, i.e., a rate above the riskless security yield. Uncertainty is introduced in two variables: the amount of deposits, which are exogenous, and the return on loans. Pringle assumes, without any justification, that the expected rate of return on the bank's loan portfolio is equal to the riskless security rate plus a risk premium plus a monopoly premium, i.e., the risk and the monopoly premia are additive. The objective of the bank is to maximize its value as a firm. The new element in the solution of this model is that the first order conditions take into account changes in the valuation of the banking firm due to the riskiness of a certain portfolio composition. In other words, the marginal cost of loans incorporates the change in the market valuation of the bank's profits owing to the additional risk of a new loan.

James (1976) tries to justify in a formal model Pringle's hypothesis that monopoly and risk premia can be decomposed additively. He finds that under general conditions these two premia can indeed be decomposed additively, but that there would still be a third interactive term. This interactive term can be interpreted as reflecting the change in the riskiness of a portfolio because of a new loan.

Finally, Merris (1979) develops a model of banking behavior with risk aversion, market power and uncertainty in both quantities and returns of balance sheet items. This model is very general, but also quite complex. It may be used, as Merris does, to estimate the parameters empirically and to perform policy simulations.

9. Discrimination among customers

Banks may be interested in discriminating among customers for several reasons. Borrowers might have different default risks. Likewise, depositors might have different withdrawal probabilities. As a result, banks will try to discriminate among customers according to their risk class. 1/

The more basic form of discrimination arises when lenders or depositors with the same objective risk are prepared to pay or ask for different interest rates. A bank with monopoly power will try to discriminate among its customers according to their readiness to accept a certain interest rate. Sylla (1969) sets out a simple model of a perfectly discriminating monopolist in the loan market, and argues that this model is appropriate to explain the banking behavior in local rural areas in the U.S. postbellum period. The cases of the perfectly discriminating monopolist and the one-price monopolist differ markedly in their economic implications. A perfectly discriminating monopolist does not generate any static inefficiency, but simply generates income transfers among agents. In a partial equilibrium framework, the amount of loans and deposits would be the same as in perfect competition, although the average rates would differ.

10. Equity capital as a decision variable

In a world without taxes and other imperfections in the capital market, the amount of equity capital for any firm is a matter of indifference. This is just a weak version of the Miller-Modigliani theorem. Pringle (1974b) introduces "ad hoc" extra costs of borrowing and issuing new equity 2/ to obtain an optimum amount of capital for

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1/ If banks have imperfect information, they may find profitable to discriminate arbitrarily inside any risk class through credit rationing because of adverse selection and incentive effects (see Stiglitz and Weiss (1981)).

2/ Above their risk-adjusted market value.

a bank with monopoly power in the loan market. Deposits are exogenous and stochastic in this model. If the extra cost of borrowing is higher than issuing new equity, the solution will be interior. The bank will be interested in having a positive amount of capital to decrease the expected extra cost of borrowing when the realized amount of deposits is lower than expected. Pringle emphasizes that "in addition to the traditional function of risk bearing, capital is important in adjusting the maturity structure of liabilities." 1/

11. Multiperiod horizon

The introduction of several periods is trivial if the objective function of the bank is the discounted sum of expected profits, and variables in one period do not depend on variables of other periods. Indeed, the multiperiod intertemporal solution in this case will just be the sequence of one-period solutions. The essential feature of intertemporal models, however, is to highlight how variables at different points in time are linked.

Goldfeld and Jaffee (1970) study the intertemporal linkage in asset holdings. Their model tries to explain the behavior of a savings and loan association with market power in the deposit side. The only earning assets that this institution holds are mortgages that can be bought in a competitive market, but not resold. Consequently, the amount of mortgages outstanding during this period determines the minimum amount of mortgages that will be outstanding during the next period. In addition, the savings and loan association cannot borrow or issue more equity, so the minimum amount of deposits to be obtained next period is also constrained. A feature of this model is that the present deposit interest rate depends not only on present mortgage rates, but also on past and expected future rates.

The intertemporal linkage in Van Loo (1980) comes from a bank-customer relationship. In particular, the amount of loans today increases the demand for deposits tomorrow, since they attract possible future depositors. As a result, it will be optimal for the bank to sacrifice part of the market power on the loans in the current period in order to increase future deposits and, hence, profits.

III. Monetary Policy with a Monopolistic Banking Sector

The literature on the consequences of market structure in the banking sector for monetary policy is rather scarce. This section reviews four articles. Aftalion and White (1977) develop a model where the banking sector behaves as a single monopolist. VanHoose (1983) builds a model where there are a large number of banks, but the banking sector is completely segmented, i.e., each bank is a monopolist in a certain

1/ Pringle (1974b), p. 792.

area. Vanhoose (1985) develops a model of oligopolistic banks in the deposit markets with the degree of competition varying parametrically according to the number of banks. Finally, Startz (1983) sets out a model of monopolistic competition. The purpose of the first two articles is to discuss the instruments for controlling the amount of money, loans, and deposits. The purpose of the third article is to analyze the relationship between the degree of competition and monetary control. The purpose of the fourth article is to discuss the incidence of deposit interest rate ceilings on the money demand function.

1. Simple model with retention of deposits

Aftalion and White (1977) derive the consequences for monetary control of a variant of the model presented in subsection II-5, in which the monopolistic bank retains part of the loans made as deposits. Other considerations like real costs, service charges, liquidity, soundness, risk, and uncertainty are ignored. The model has three sectors: nonfinancial agents, the central bank, and commercial banks. Aftalion and White analyze the comparative static results for two banking market structures--monopoly and perfect competition--and two interest rate regimes--an exogenous and an endogenous deposit interest rate. This survey will first review the exogenous regime, and then comment on the special features of the endogenous one.

The behavior of the nonfinancial agents is summarized by the demands for loans, deposits, and currency. In symbols:

$$L = l(r_L) \quad \text{(demand for loans) } \underline{1/} \qquad (51)$$

$$D = q(r_D)M,\ q' > 0 \quad \text{(demand for deposits) } \underline{2/} \qquad (52)$$

$$C = [1 - q(r_D)]M \quad \text{(demand for currency)} \qquad (53)$$

where C = currency

M = total amount of money, i.e., $M = C + D$, and

q = proportion of money held in deposits.

The central bank balance sheet identity is:

$$A + B = C + R \qquad (54)$$

1/ Aftalion and White (1977) add a shift variable as a parameter of this function to facilitate comparative static analysis.

2/ Aftalion and White (1977) define $C = e(r_D)D$, so q above is related to e in the following way:

$$q(r_D) = \frac{1}{1 + e(r_D)}$$

where A = central bank advances to commercial banks, and

B = other assets owned by the central bank.

In the monopoly case, the commercial bank sets r_L in order to maximize profits, i.e.,

$$\max_{(r_L)} \Pi = r_L L - r_D D - r_A A \tag{55}$$

subject to:

$$L + R = D + A + E \quad \text{(balance sheet identity)} \tag{56}$$

$$L = l(r_L) \quad \text{(demand for loans)} \tag{57}$$

$$R = kD \quad \text{(definition of required reserves)} \tag{58}$$

$$D = q(r_D)M \quad \text{(demand for deposits).} \tag{59}$$

Observe that the only differences from subsection II-6 are the specific form of the deposit demand function and the substitution of S by -A (the portion of the capital market where the monopolistic bank is a price taker is interpreted as the advances from the central bank).

The total amount of money, M, is not considered exogenous by the commercial bank since it is affected by the loans offered. Consolidating the central bank and the commercial bank balance sheets:

$$M = C + D = B + L. \tag{60}$$

Since B is assumed to be an exogenous variable, the amount of money will increase one to one with the amount of loans offered.

The first order conditions for the profit maximizing commercial bank imply:

$$r_L(1 + \frac{1}{\varepsilon_L}) + q(r_A(1 - k) - r_D) = r_A. \tag{61}$$

Therefore, r_L is a function of r_A, r_D, and k, i.e.,

$$r_L = r_L(r_A, r_D, k) \tag{62}$$

$$\frac{\partial r_L}{\partial r_A} > 0, \frac{\partial r_L}{\partial r_D} > 0, \frac{\partial r_L}{\partial k} > 0. \tag{63}$$

In the competitive case, r_L is determined by the equilibrium condition in the loan market:

$$r_L = r_A \tag{64}$$

i.e., r_L is only a function of r_A.

Thus, the model in each market structure can be summarized in three equations. In the monopoly case:

$$M = B + L \quad \text{(from the balance sheet identities)} \tag{65}$$

$$L = L(r_L) \quad \text{(from the nonfinancial sector), and} \tag{66}$$

$$r_L = r_L(r_A, r_D, k) \quad \text{(rate set by monopolist).} \tag{67}$$

In the competitive case, the first and second equations are the same, and the third should be replaced by:

$$r_L = r_A \quad \text{(equilibrium condition).} \tag{67a}$$

The endogenous variables of the model are M, L and r_L. The exogenous variables are B, r_A, r_D, and k. In addition, the model is recursive: r_A, r_D, and k completely determine r_L, r_L determines L, and B and L determine M.

Irrespective of the market structure, an increase in the rate on advances from the central bank (r_A) increases the lending rate r_L, because the opportunity cost of lending rises. As a consequence, L and M are reduced. The policy variables r_D and k are, however, effective instruments for monetary control only in the monopolistic case. In this situation, an increase in r_D or k reduces the profitability of deposits and, hence, the bank has less incentive to lend and thereby increase its deposits. Consequently, r_L rises, and L and M fall. In contrast, in the competitive case, banks do not adjust the amount of loans to alter the amount of deposits, because the opportunity cost of lending is fully reflected in r_A, and is not affected by r_d or k.

If the deposit interest rate is endogenous, the model can be summarized in four equations. In the monopoly case:

$$M = B + L \quad \text{(from the balance sheet identities)} \tag{68}$$

$$L = L(r_L) \quad \text{(from the nonfinancial sector)} \tag{69}$$

$$r_L = r_L(r_A, r_D, k) \quad \text{(rate set by the monopolist), and} \tag{70}$$

$$r_D = r_D(r_A, k) \quad \text{(rate set by the monopolist)} \tag{71}$$

where $\frac{\partial r_L}{\partial r_A} > 0$, $\frac{\partial r_L}{\partial r_D} > 0$, $\frac{\partial r_L}{\partial k} > 0$, $\frac{\partial r_D}{\partial r_A} > 0$, $\frac{\partial r_D}{\partial k} > 0$.

In the competitive case, the first two equations are still the same, and the last two should be replaced by:

$r_L = r_A$ (equilibrium condition in the loan market), and (70a)

$r_D = \frac{r_A}{1 - k}$ (equilibrium condition in the deposit market). (71a)

The structure of the above model is similar to the exogenous r_D regime. The structure is still recursive. The comparative static results work in the same fashion except that now r_D is determined by r_A and k. If the deposit market is competitive, the reserve ratio k becomes ineffective to control r_L and, hence, L and M, regardless of the market structure for loans. Intuitively, the marginal profitability of deposits becomes zero, and the opportunity cost of loans becomes independent of the deposit side, and so of k.

Are the comparative static results of this simple model by Aftalion and White robust in relation to the further complexities in banking considered in Section II? The results about the consequences of changes in r_A seem to be very general and robust. When banks can borrow indefinitely and without any penalty from the central bank, the key variable for monetary control is the discount rate. When this rate is increased, the loan rate increases and the quantities of loans and money decrease regardless of the market structure. The other comparative static results seem much more specific to this model. For example, if the model incorporates a liquidity constraint or a penalty cost of borrowing, it is not clear any more that an exogenous increase in r_D will increase r_L. Indeed, an increase in r_D will increase the amount of deposits, and so provide the banking sector with extra liquidity. The shadow cost of lending is reduced. Consequently, loans will be expanded and r_L lowered.

2. Disaggregation of financial markets and real costs

The previous model by Aftalion and White (1977) is thought appropriate mainly for European countries. In these countries, the authors view a concentrated banking sector as successfully colluding, and the monetary authorities pegging the discount rate and accepting unlimited advances or deposits at that rate. VanHoose (1983) builds a model more suited to the institutional circumstances of the United States, in which banks have local monopoly power, and are small relative to the banking sector. Also, the monetary authority seeks to peg either the interbank rate (Federal funds rate) or the level of currency and unborrowed reserves. 1/

In a more technical sense, VanHoose tries to improve the previous model by Aftalion and White in two directions. First, none of the demand and supply functions is assumed to be "ad hoc", but they are derived from optimizing behavior of economic agents. Second, the financial sector is more disaggregated. In particular, securities in a restricted sense are distinguished from interbank credits and from discounts at the central bank.

Demand for and supply of assets by the private nonfinancial sector are derived from a portfolio selection problem. Firms and households maximize the expected return on their portfolios subject to a wealth constraint and a cost function of holding a certain combination of assets (transaction costs, inventory costs, and others). This cost function is assumed to be convex and additively separable. 2/ The first property is important to ensure interior solutions to the optimizing problems. The second property plays a role in eliminating ambiguous signs from the first derivatives of the resulting demand and supply functions. Indeed, the signs of these derivatives are such that assets have the property of being gross substitutes, i.e., an increase in the return on one asset increases the net demand for this asset, and reduces the net demand for all the others.

In the monopolistic case, the optimizing problem of banks is essentially the same as the one stated in subsection II.3, but incorporates additional assets and more complete demand functions. All banks are price takers in the market for securities, interbank credit and central bank advances. In contrast, they are price setters in the loan and deposit markets. Each bank behaves without any strategic interaction with others, i.e., banks are not affected at all by the rates set by their neighbors. 3/ Banks' cost function of holding a combination of assets and liabilities is similar to those of firms and households. Finally, banks are not able to retain as deposits any proportion of the loans offered.

1/ Because of accounting identities this is equivalent to pegging the level of securities held by the central bank.

2/ VanHoose assumes that the second partial derivatives are positive, which implies that the function is convex, and the cross derivatives are zero, which implies that the function is additively separable.

3/ This feature is clearly unsatisfactory since it assumes that the market for each bank is completely segmented.

Aggregating the net demands of all the agents in the economy, and using Walras' Law to disregard the market equilibrium for high powered money, VanHoose summarizes the equilibrium conditions of the model in four equations:

$$S^d(\overset{+}{r_S}, \overset{-}{r_F}, \overset{-}{r_B}, \overset{-}{r_L}, \overset{-}{r_D}, \overset{+}{r_K}, \overset{?}{k}) + SCB = 0 \tag{72}$$

$$r_L = r_L(\overset{+}{r_S}, \overset{+}{r_F}, \overset{+}{r_B}, \overset{-}{r_K}, \overset{?}{k}) \tag{73}$$

$$r_D = r_D(\overset{+}{r_S}, \overset{+}{r_F}, \overset{+}{r_B}, \overset{-}{r_k}, \overset{?}{k}) \tag{74}$$

$$F^d(\overset{+}{r_S}, \overset{-}{r_F}, \overset{+}{r_B}, \overset{-}{r_K}, \overset{?}{k}) = 0 \tag{75}$$

where S^d = aggregate net demand for securities, excluding the central bank

SCB = holdings of securities by the central bank

F^d = aggregate net demand for interbank credits

r_S = interest rate on securities

r_F = interest rate on interbank credit

r_B = interest rate on rediscounts at the central bank

r_L = interest rate on loans

r_D = interest rate on deposits

r_K = interest rate on reserves

k = reserve requirement ratio

The signs on the arguments refer to the partial derivatives.

The first and fourth equations are simply the equilibrium conditions on the securities and the interbank credit markets. The other two are meant to represent the rate setting behavior by banks.

If the monetary authority targets r_F, the endogenous variables are SCB, r_S, r_L and r_D. In this case, the model is recursive. Equation (75) determines r_S. Equations (73) and (74) determine r_L and r_D. Finally, equation (72) determines SCB.

If the monetary authority targets the amount of currency and unborrowed reserves, SCB becomes exogenous. In this case, the endogenous variables are r_S, r_F, r_L and r_D. The model is no longer recursive. However, the model can be simplified to a two equation model by substituting equations (73) and (74) into equation (72).

The comparative static results in either case are not surprising. The interbank interest rate r_F is the key control variable when it is targeted. An increase in r_F will increase r_S, r_L and r_D. The holdings of securities by the central bank, (SCB) and the discount rate are the key control variables when the amount of currency and unborrowed reserves is targeted. A reduction of SCB (money contraction) or an increase in r_B will increase r_S, r_L and r_D. 1/ The other comparative static results are mostly ambiguous.

The results of the monopolistic model are compared in VanHoose's paper with those of a model with perfect competition in all banking markets (i.e., markets characterized by pure rate-taking behavior). The qualitative effects of policy instruments remain the same under SCB targeting. However, there are some differences under r_F targeting. In this case, some of the definite signs under monopoly become ambiguous and vice versa. For example, r_S no longer increases unambiguously with an increase in r_F when competition prevails. Using VanHoose's words, this result is explained as follows:

"...the initial effects of an increase in r_F are rises in r_S, r_L and r_D as banks reduce the size of their asset portfolios and substitute deposits and Federal discounts for Federal Funds' borrowings. However, increases in these rates have feedback effects in the Federal Funds market as supply responses in the security and loan markets occur, thereby causing banks to readjust their portfolios in the opposite direction from that of the initial effect of the rise in r_F. This secondary effect, in turn, puts new upward pressure on r_F as banks seek funds to augment their portfolios. The rises in r_S and r_L also reduce deposit demand, reinforcing the upward pressure on r_F as banks substitute

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1/ Some additional hypotheses about the relative magnitude of the partial derivatives are required to obtain these results: "In this case, no determinate results emerge unless the correspondence principle is invoked. If it is assumed that the time derivatives of r_S and r_F are increasing functions of an excess supply of securities and an excess demand for Federal Funds, respectively, while the time rates of change in r_L and r_D are increasing functions of negative deviations from their equilibrium levels, then the following sets of comparative static results can be obtained." (VanHoose, op. cit., p. 396) In other words, VanHoose is assuming a certain kind of stability condition.

into Federal Funds as deposit funds become less readily available. Maintaining the newly set level for r_F could then require that SCB be increased by enough to more than offset the initial increase in r_S, hence the undetermined effect on r_S reported..." 1/

VanHoose's article is interesting because it introduces more complete and general equilibrium oriented models, but in the process many of the comparative static results are ambiguous.

3. Bank market structure and monetary control

The two models examined so far derive and contrast the monetary effects of potential policy instruments under the two extreme cases of perfect competition and monopoly. However, these models miss two essential elements for studying the implications of different bank market structures on monetary control: uncertainty, and the interactions between the real and the financial sectors of the economy. 2/ In addition, since the degree of competition is not introduced explicitly, comparisons can only be made across alternative models and not in the context of the same model. VanHoose's (1985) article is aimed at overcoming these problems. First, a model of oligopolistic deposit market is developed and the degree of competition is introduced parametrically through the number of banks in the deposit market. Second, the interrelations between the financial and the real sectors of the economy are modelled using a traditional macroeconomic framework. Third, the ability to control a monetary aggregate is formulated properly, by permitting the equations of the system to be shocked by random variables.

Finally, by incorporating the model of an oligopolistic deposit market within the macroeconomic framework, the relationship between the degree of competition and the ability to control a monetary aggregate.

a. Oligopolistic deposit market

There are n identical banks, which exploit their market power in the deposit market. The loan market is assumed perfectly competitive, and indistinguishable from the securities market. The interaction between banks is modelled by assuming that each one of them entertains Cournot conjectures, i.e., takes the amount of deposits supplied by their competitors as given. 3/

1/ VanHoose (1983), p. 398.

2/ For a recent extension of the Aftalion and White and VanHoose models to incorporate the interaction between real and financial sectors, see Barry Johnston (1986).

3/ The model presented here is a simplified version of VanHoose: excess reserves are assumed equal to zero and interest on deposits is the only cost faced by banks.

The problem of an individual bank is:

$$\underset{(r_d)}{\text{Max}}\ \Pi^i = r_s S^i - r_D D^i \tag{76}$$

subject to:

$$S^i = D_i + R^i \qquad \text{(balance sheet identity)} \tag{77}$$

$$D^i = d(r_p) - \sum_{j \neq i} D^i \qquad \text{(demand for deposits), and} \tag{78}$$

$$R^i = qD^i \qquad \text{(required reserves).} \tag{79}$$

The solution of this problem is characterized by:

$$r_D[1 + (D^i/D)(1/\varepsilon_D)] = (1 - q)r_S \tag{80}$$

Furthermore, with identical firms, $D = n.D^i$, and this yields:

$$r_D[1 + (1/n(\varepsilon_D)] = (1 - q)r_S \tag{81}$$

In this framework, the sensitivity of r_D with respect to r_S is affected by the degree of competition represented by the number of banks. To underscore this, VanHoose assumes that the demand function for deposits is isoelastic, so that ε_D is equal to a constant e. Under this assumption,

$$r_D = \Theta \cdot (1 - q) \cdot r_s$$

where $\Theta = n/(n + e)$. Observe that Θ increases with the number of banks in the deposit market. Indeed, when $n = 1$, $\Theta = 1/(1 + e)$, and when n tends to infinity, Θ tends to one. Thus, if the deposit demand elasticity is constant, the sensitivity of r_D with respect to r_s increases with the degree of competition. This result proves to be very powerful in the determination of the consequences of bank market structure for monetary control, as shown subsequently.

Unfortunately, however, the conclusion that the sensitivity of r_D with respect to r_s increases with the number of banks is not robust under alternative and equally reasonable specifications of the demand function for deposits. Indeed, assume, for example, that this function has a constant semi-elasticity, i.e., $[d'(r_D)] \cdot 1/D = \tau$, where τ is a constant, instead of a constant elasticity. The relationship between r_D and r_s will then be:

$$r_D = [(1 - q) \cdot r_S] - 1/(n \cdot \tau) .$$

Observe that now the sensitivity between r_D and r_s is independent of n. In other words, the issue of how the sensitivity between r_D and r_s is affected by the degree of competition cannot be settled on theoretical grounds only, but some empirical knowledge about the deposit demand function is needed.

b. The degree of competition and monetary control

In order to analyze the consequences of competition in the deposit market for the ability to control a monetary aggregate, an IS-LM-Lucas' supply curve framework is used. The distinctive assumptions of the model are:

1. Deposits are the only monetary asset, and the demand for deposits is a function of the opportunity cost of holding them as measured by the difference between interest rates on securities (r_S) and deposits (r_D).

2. The deposit interest rate is determined endogenously in an oligopolistic market. 1/

3. The holdings of excess reserves decrease with the interest rate on securities. 2/

4. Each equation of the system is shocked by a random variable of mean zero, and uncorrelated with past shocks and present shocks in other equations.

In this framework, the government is assumed to set a target for the amount of deposits D*, and to achieve the target it either controls the amount of reserves or the level of the securities rate r_S. Due to random shocks in the system, the realized amount of deposits will in general differ from D*.

Two possible regimes of reserve accounting are considered: contemporaneous required reserves and lagged required reserves. These two regimes, combined with the two possible operating systems of money supply control, result in four possible policy combinations.

The algebraic formulation used by VanHoose will be depicted graphically in what follows. To this end, the reduced form equations

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1/ There is a technical inconsistency about the form of the deposits demand curve in VanHoose's paper. An isoelastic demand curve is assumed in the description of the deposits market. In contrast, an isosemi-elastic demand curve is assumed in the construction of the macroeconomic framework

2/ Observe that this is consistent with the results of subsection II.7. VanHoose derives this relationship in a less rigorous fashion.

for the demand for and the supply of deposits as a function of r_S--from now on called deposit demand curve and deposit supply curve--are very useful.

The deposit demand curve is derived from, and owes its properties to, the equations that describe the demand for deposits, the real side of the economy and the behavior of the deposit institutions. Indeed, the demand for deposits depends in general on the difference between r_S and r_D, the price level, and the level of national income. However, taking into account the feedback effects from the real side of the economy and the deposits market, a reduced form can be constructed where the demand for deposits will depend only on r_S. Under usual assumptions, this dependence may be shown to be negative. Intuitively, an increase in the securities rate decreases the amount of deposits directly and indirectly. The direct effect is due to the larger opportunity cost of holding deposits instead of securities. 1/ The indirect effect is due to the reduction in the levels of national income and prices that will follow from an increase in r_S.

Chart 1 depicts a deposit demand curve. The continuous line represents the expected value of the amount of deposits for each r_S value. The broken lines represent the range in which it may shift. 2/

The key property of VanHoose's (1985) model is that an increase in the degree of competition will decrease the sensitivity of deposits to changes in r_S. That is, the slope of the deposit demand curve becomes steeper, as shown in Chart 1. The intuition behind this result goes as follows: an increase in the degree of competition will increase the sensitivity of r_D to changes in r_S. As a result, the opportunity cost of holding deposits, which is the difference between r_S and r_D, will be less sensitive to changes in r_S. 3/ Therefore, the amount of deposits also will be less sensitive to changes in r_S. Note that changes in the degree of competition do not change the horizontal variability of the deposit demand curve, due to the way the random shocks enter the system.

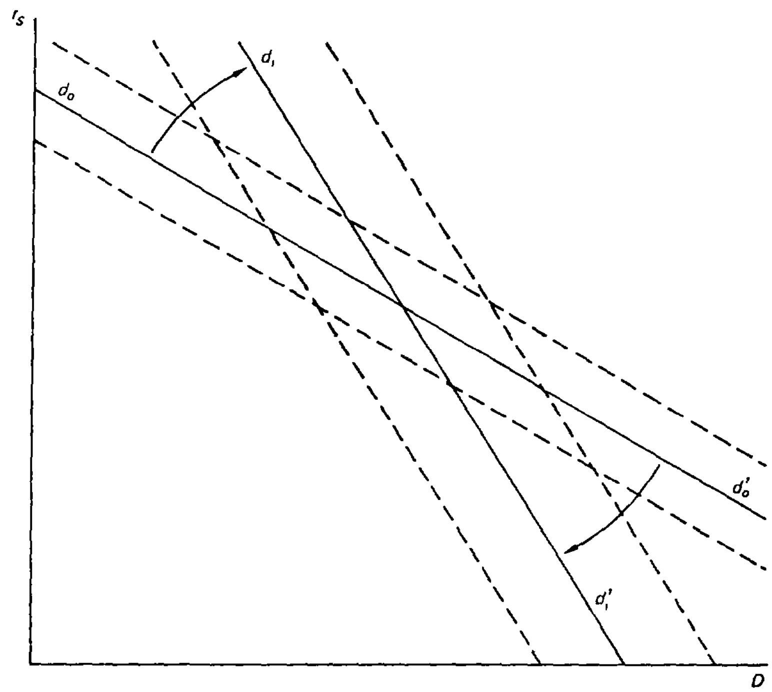
1/ Note that an increase in r_S leads to an increase in r_D, but the difference between the two rates will still widen, given the assumptions of the model.

2/ For illustrative purposes, it is best to think that the random shocks are distributed uniformly in a certain range. However, the arguments do not hinge at all on this assumption. For example, if the random shocks are assumed normal, the broken lines may be thought as representing a certain number of standard errors from the mean, and all the arguments that follow go through.

3/ Observe that a noncompetitive market weakens the effect that elimination of ceilings on deposit interest rates has on the slope of the demand for deposits. Indeed, when a deposit interest rate ceiling is binding, the sensitivity of r_D with respect to r_S is zero.

Chart 1.

Effect of an Increase in the Number of Banks on the Deposit Demand Curve



NOTE: The deposit demand curve becomes steeper when the degree of competition in the deposits market is increased. d_0d_0' represents the original deposit demand curve. d_1d_1' represents the deposit demand curve once the degree of competition is increased. The broken lines represent the range in which d_0d_0' and d_1d_1' may shift. Note that the horizontal variability of these is not affected by the increase in the number of banks.

The deposit supply curve is a reduced form of the equations that describe the market for reserves. Since the market for reserves is influenced by both the willingness of banks to hold reserves and the central bank policies regarding the supply of reserves, the shape of the deposit supply curve would differ depending upon the policy regimes.

The central question raised by VanHoose (1985) can be stated as follows: how an increase in the slope of the deposit demand curve due to a larger degree of competition will affect the variability of the realized amounts of deposits around the target value D*. The answer depends on the policy regime considered, which gives rise to three possible cases. For the sake of brevity, only Case 1 will be depicted graphically. 1/

Case 1. Contemporaneous reserve requirements and control of the amount of reserves

The deposit supply curve will slope upward, since banks will hold smaller amounts of excess reserves as r_S increases; the supply curve will be displaced by random shocks.

The effect of an increase in the degree of competition on the ability of the government to control the amount of deposit is ambiguous. Intuitively, if the amount of deposits becomes less sensitive to changes in r_S, the shocks to the deposit supply curve will be absorbed by larger variations in r_S and lower variations in the amount of deposits. However, the shocks to the deposit demand curve will be more fully transmitted to changes in the amount of deposits than before. This ambiguity is shown graphically in Charts 2a and 2b. In Chart 2a, an increase in the degree of competition leads to lower variations in the amount of deposits. In contrast, Chart 2b shows that the reverse may also be true if shocks to the supply curve are small, relative to shocks to the demand curve. 2/

Case 2. Lagged reserve requirements, and the control of the amount of reserves

An increase in the degree of competition increases unambiguously the ability of the government to control the amount of deposits. Intuitively, r_S is fully determined, but not precisely, by the deposit supply

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1/ The other cases can be depicted graphically quite easily. The main modification is that under Cases 2 and 3 the supply curve will be horizontal. Moreover, in Case 2 the curve will be displaced vertically due to the random shocks that affect bank willingness to hold reserves. On the contrary, in Case 3 the supply curve will not be subject to random shocks.

2/ VanHoose believes that this second possibility is more likely, without explaining why.

curve. The variability of the amount of deposits will clearly be reduced when its sensitivity to changes in r_S is reduced.

Case 3. Securities interest rate as the operating system to control the money supply regardless of the reserve accounting regime

The degree of competition does not effect the ability of the government to control the amount of deposits. In this case, r_S is precisely determined by the government, thus leaving demand shocks as the only possible source of variation of the amount of deposits. In addition, the demand shocks around the target level of deposits are not affected by the degree of competition.

The foregoing results may be summarized using Van Hoose's words: "...changes in bank market structure have no implications for monetary control if the Fed utilizes an interest rate-oriented operating procedure, whereas under a procedure in which the level of bank reserves is the operating target of the Fed, the effects upon monetary control of an increase in bank market competition depend crucially upon the institutional framework for reserve accounting--if required reserves are based on deposit levels from a previous period, an increase in competition in local bank deposit markets acts to reduce the variability of a monetary aggregate. In contrast, unsystematic monetary variability is most likely enlarged by increased bank competition under a system of contemporaneous reserve requirements." 1/

c. Deposit interest rate ceilings

Startz (1983) addresses the question of how the policy on deposit interest rate ceilings affects the monetary system when the banking system is characterized by monopolistic competition. He is concerned about the results on both the level of the money demand (in his model the only kind of money is demand deposits) and the slope of the money demand function with respect to the "market" interest rate (interest rate in the bond market). The policy changes considered are modifications in the level of the ceilings, in the number of financial institutions, and complete removal of the interest rate ceilings.

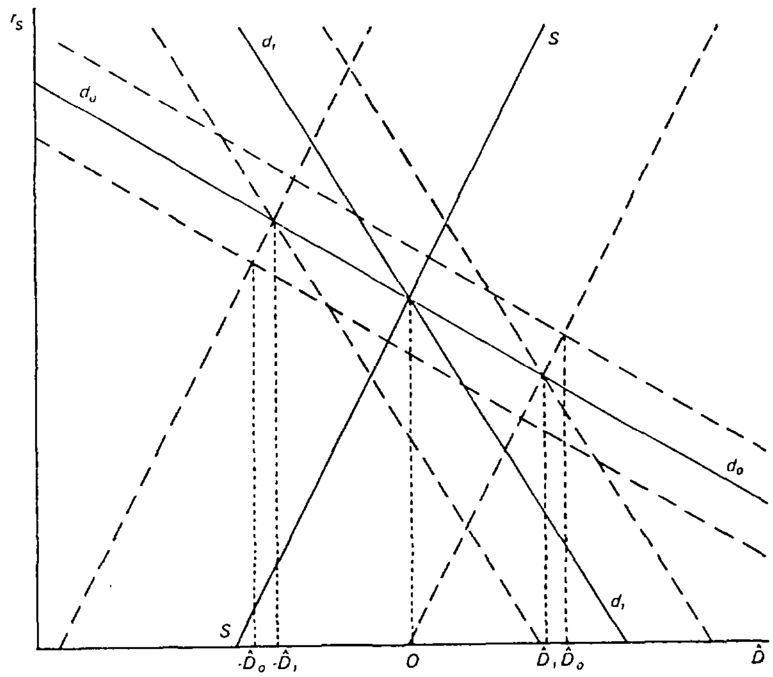
If the market for deposits is perfectly competitive, the answers are well known and straightforward. For example, removal of interest rate ceilings will increase the demand for money, and reduce the sensitivity of the demand for money to variations in the "market" interest rate.

The structure of Startz's banking sector model is simple and manageable. All banks are assumed to be identical, and enter the model in a symmetric way. Each individual bank faces a linear demand function for deposits that depends on its own deposit interest rate, the

1/ VanHoose (1985), p. 299.

Chart 2a.

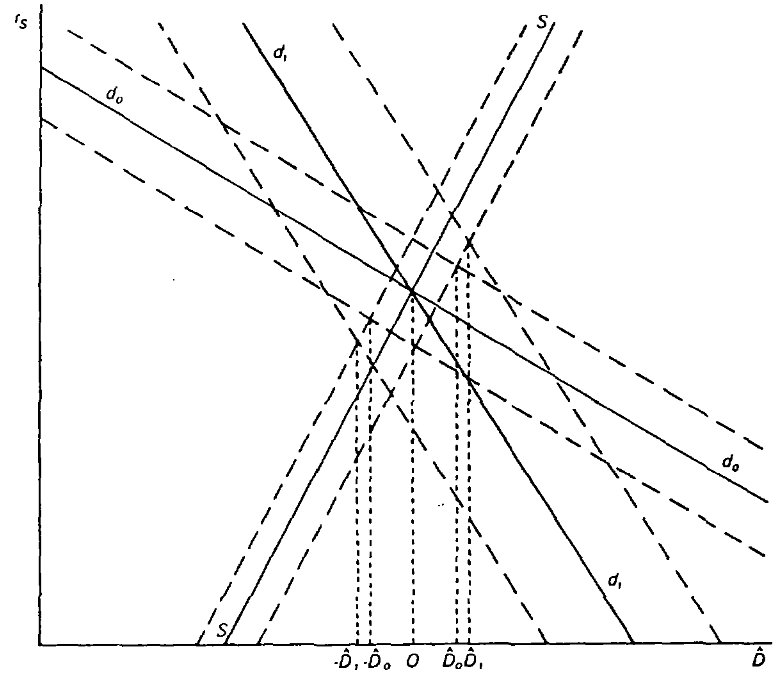
Effect of an Increase in the Number of Banks on the Unsystematic Variability of Deposits with Contemporaneous Reserve Accounting and Control of Reserves



NOTE: The range of unsystematic variations of deposits is reduced from $-\hat{D}_0\hat{D}_0$ to $-\hat{D}_1\hat{D}_1$. Contrast this possibility with the opposite case depicted in Chart 2b.

Chart 2b.

Effect of an Increase in the Number of Banks on the Unsystematic Variability of the Amount of Deposits with Contemporaneous Reserve Accounting and Control of Reserves



NOTE: The range of unsystematic variations of deposits is increased from $-\hat{D}_0\hat{D}_0$ to $-\hat{D}_1\hat{D}_1$. *Contrast this possibility with the opposite case* depicted in Chart 2a.

deposit interest rates of other banks, and the "market" interest rate. Each bank is sufficiently large relative to the banking sector to have monopoly power, but sufficiently small to take the action of other banks as given; this is the classic Chamberlinian assumption. Banks can pay implicit or explicit interest on deposits. The asset side of banking is extremely simplified by assuming that the marginal return on earning assets is the "market" interest rate, which is given exogenously, and that banks have to hold a given proportion of deposits as nonearning reserves.

The model is solved under two possible regimes: with a binding ceiling on the explicit interest rate and without it. In the first case, the implicit interest rate is found to be a function of the exogenous variables: the explicit interest rate ceiling, the "market" interest rate, the proportion of reserves, the number of banks and the parameters of the demand function. In the second case, the implicit interest rate will be zero, since the demand function is linear and explicit interest is more efficient. The explicit interest rate will be determined now by the exogenous variables.

The simplicity of this model permits strong conclusions about the impact of changes in policy, particularly if something is known about the parameter values. An increase in the explicit interest rate ceiling increases the demand for money, but leaves its slope with respect to the "market" rate unchanged. The other comparative static results--relating to changes in the number of banks, and the removal of the interest rate ceiling--depend on the parameter values. Using empirical estimates for the United States, Startz concludes that increasing the number of banks will increase the implicit interest rate and its sensitivity to the "market" rate. Finally, the removal of explicit interest rate ceilings will increase deposit demand and the sensitivity of the deposit rate to the "market" rate.

IV. Conclusions

The literature on the implications of the banking market structure for monetary policy is still in its early stages. Most of the articles surveyed dealt with the issue only tangentially since their main concern was directed to the behavior of banks rather than to monetary policy issues. Moreover, the few articles that really focus on monetary policy differ greatly in model specification, and their results hinge heavily on particular assumptions. Consequently, the primary conclusion of this survey is that considerable further work is needed in this area. So far, the theoretical literature is only useful in identifying some of the potential monetary policy issues raised by the existence of a noncompetitive banking sector, and giving some partial answers to them.

The policies undertaken in a process of financial liberalization are captured in the models surveyed in this paper by:

a. an increase in the degree of competition in banking services;

b. a reduction of the amount of required reserves, and in general of required investments whose yield is below the market; and

c. a relaxation or a complete removal of interest rate ceilings.

An increase in the degree of competition in the deposit market will serve to increase the volume of deposits, and also influence the ability of the government to control a monetary aggregate. The degree of competition is measured either by the elasticity of the demand for deposits in the monopolist models, or by the number of banks in the oligopolistic models. In either case, there is wide agreement that more competition will increase the volume of deposits. The results with respect to monetary control are much more complex and ambiguous. The ability of the government to control a monetary aggregate is a positive function of the sensitivity of deposits to changes in the securities' interest rate. The effect of a greater degree of competition on this sensitivity is, in general, ambiguous. However, the models of VanHoose and Startz yield unambiguous results, due to the form of the demand function for deposits chosen by VanHoose (1985) and the specific values of the parameters chosen by Startz (1983); these results imply that the sensitivity of the volume of deposits has a negative relationship to both the securities rate and the degree of competition. Consequently, the ability to control a monetary aggregate will decrease with more competition in the market for deposits.

A reduction of the amount of required reserves or required investments at below-market interest rate will increase the deposit interest rate and, therefore, the volume of deposits. The partial relaxation or the total removal of deposit interest rate ceilings will have the same effect. These two results are robust for all the market structures considered.

An increase in the deposit interest rate ceiling in a monopolistic market will, however, have an ambiguous effect on the loan interest rate, and therefore on the volume of loans. This is due to the interrelationships between the deposit and loan markets which could arise from scope economies in real resources, liquidity costs or constraints, and demand complementarities. The first two of these interrelationships will tend to reduce the loan rate when the deposit rate is raised. Indeed, an increase in the deposit rate will increase the amount of deposits, so the real and the liquidity costs of servicing loans will be reduced. In contrast, in the presence of demand complementarities, the loan rate would rise as the deposit rate rises. For example, if a certain fraction of loans is redeposited in the same bank, an increase in the deposit rate makes it less attractive to capture deposits through the fraction of loans redeposited. Therefore, the bank will reduce the amount of loans and raise the loan rate.

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