

A Systematic Study of the Economics of Financial Institutions Based on the Maximum Profit Model

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Abstract. Most of the existing theories for promoting financial deepening ignore the structural factors of banking markets in developing countries and do not include intermediation by banks in the systematic study of financial institutions. In this paper, we will introduce intermediate business in banking under the assumption of oligopoly in the banking market, analyze the profit maximization conditions of commercial banks, and show that developing countries can, through market monopoly power and the development of intermediate services of banks, to absorb deposits, maximize profits, and promote financial deepening without necessarily relying on the interest rate marketization. The conclusion in this paper has significant policy value for promoting financial deepening and sustainable development of financial institutions in developing countries.

Keywords: Maximum Profit Model; bank market structure; financial Institutions.

1. Introduction

In 1973, Ronald I. McKinnon and Edward S. Shaw, based on the research of their predecessors, published their respective books *Money and Capital in Economic Development* and *Financial Deepening in Economic Development*, which marked the founding of “financial development” theory [1,2]. They put forward the famous “financial repression” theory and “financial deepening” theory, which attributed the economic underdevelopment to financial repression in developing countries. McKinnon and Shaw and their followers have argued that one of the main instruments of financial repression in developing countries is artificially low interest rates on deposits, i.e., the government intentionally fixes interest rates on (nominal) deposits below the equilibrium level. The consequences of this are low savings, low investment and low growth, and thus financial liberalization is advocated. One of the main measures to deepen finance is interest rate liberalization, which promotes higher deposit rates, narrower deposit and loan spreads, more intense competition for deposits among banks, and increased savings mobilization capacity of financial intermediaries, and in this way, increases the degree of monetization of the economy and the depth of finance.

Other economists introduced the endogenous growth theory into the financial development theory and put forward the “financial constraints theory” [3], which argued that regulatory measures such as controls on deposit rates, controls on lending rates, restrictions on entry, and restrictions on competition from capital markets are beneficial for financial deepening because they serve to discourage banks from engaging in excessive competition and create rental opportunities for both banks and the productive sector [4]. They emphasized that in the absence of regulation, excessive competition among banks would raise interest rates on deposits and loans, which would raise the cost of capital and reduce investment. Higher lending rates will lead to adverse selection problems for banks as the average quality of borrowers declines, in addition higher deposit rates increase the cost of doing business and can lead to banks to relax their supervision of borrowers in order to save regulatory costs.

Whether in favor of or against financial liberalization or financial constraints to promote financial deepening, what they have in common is that commercial banks are the main body of the financial market in developing countries, and they all take commercial banks as the focus of financial development theories, and emphasize the importance of interest rate factors in the process of financial deepening. However, most of these theories have ignored the structural factors of banking markets in developing countries.

Banking markets in developing countries often do not lend themselves to the assumption of perfect competition, being more oligopolistic in nature; and banks' sources of income are not limited to deposit and lending but also to a wide range of intermediation services. These affect the behavioural choices of banks to maximize profits and influence the path of financial deepening. If these factors are considered in the premise assumptions of financial development theory, it will obviously change the original theoretical conclusions. In this paper, we will analyze the profit maximization conditions of commercial banks by introducing intermediary services in banking under the assumption of oligopoly in the banking market and show that developing countries can absorb deposits, maximize profits and promote financial deepening through market monopoly power and the development of intermediary bank services without necessarily relying on interest rate marketization.

2. Bank market structure and profit maximization conditions

2.1. Bank market structure

In terms of depositors' deposit preferences, some depositors deposit mainly for the purpose of obtaining interest income on deposits, and the other part of the depositors (such as enterprises and governments) is mainly for the purpose of obtaining the bank's intermediary services (we can summarize it as a synthetic service consisting of the convenience of bank branches, clearing, custody and other related banking services). Therefore, for the former, the bank needs to rely on interest rate policy to mobilize the deposits of this part of the depositors; for the latter bank will need to use the service rate policy to absorb deposits. Here, the bank's source of income comes not only from the deposit and loan spreads, but also from service fee income from intermediation. Consequently, both the service charge rate and the interest rate have an impact on the mobilization of bank deposits and on bank profits, unlike the theory of financial liberalization, which considers only the impact of the interest rate. Since the market monopoly power of banks affects the determination of bank interest rates and service charge rates, it also affects the ability of banks to absorb deposits and bank profits, which in turn affects financial development. Chiappori et al. show that in the presence of an interest rate cap, banks can maximize their profits by expanding the size of their network and lowering their lending rates in the long run [5]. This empirically reflects the fact that taking into account the structure of the banking market changes the conditions under which banks maximize their profits, and that financial development is not necessarily obtained through an increase in interest rates on deposits and loans.

With the introduction of the bank market structure, the factors affecting the profit realized by the bank will not be limited to the bank's cost of deposit and loan operations and the market deposit and loan rates. This paper summarizes the factors affecting banks' profitability as follows: (1) the operating costs of bank resources (including the operating costs of deposit and loan operations and intermediary operations); (2) the monopoly power of the market in the supply of loans (which is conducive to raising the equilibrium interest rate on loans); (3) the monopoly power of the market in the absorption of deposits (which is conducive to lowering the equilibrium interest rate on deposits); and (4) the risk which is caused by the uncertainty of the bank's operations. We then analyze the profit maximization conditions from these four aspects.

2.2. Conditions for profit maximization on bank deposits

We assume that the banking sector is an oligopolistic market consisting of n symmetric banks i ($i=1 \dots n$). Bank i operates in m regions j ($j=1 \dots m$) of its country. Each bank i will accumulate deposits D_i which consist of deposits in the m separate regions in which bank i operates. The total deposits in each region are D_j which consists of the deposits of all banks in that region and then the total deposits of the banking sector consist of the deposits of all regions. According to the above assumptions, we have:

$$\sum_j D_{ij} = D_i, \sum_i D_{ij} = D_j, \sum \sum_{ij} D_{ij} = nD_i = mD_j = D \quad (1)$$

The banking sector takes in deposits D and provides intermediate services T . Assume that banks face a downward-sloping demand curve for deposits (loans) and services L_d+T_d and an upward-sloping supply curve for deposits D_s , as shown in Figure 1. In an oligopolistic market, the amount of deposits and services absorbed through bank intermediation, T , are complementary, i.e. depositors can only enjoy intermediary bank services if they supply deposits, otherwise they cannot enjoy intermediary bank services. The ratio of total deposit supply D to the provision of intermediary banking services T is uncertain, depending on the extent to which depositors are motivated to make deposits by interest income or by intermediary banking services.

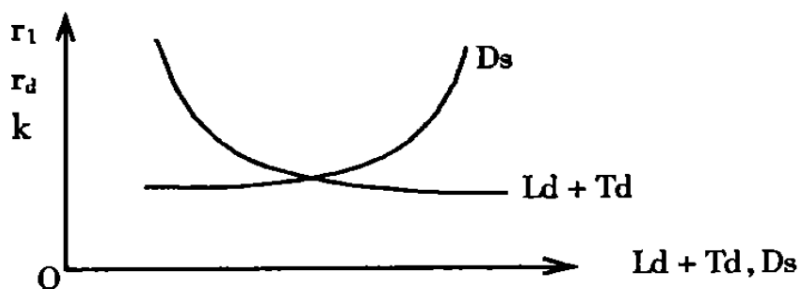


Fig. 1 Supply and Demand Curves for Banks

Assuming that the national market is segmented and that the market interest rate on deposits r_{dj} and the service charge rate k_j vary from region to region, the market supply function for deposits faced by bank i in region j is $D_j(r_{dj}, k_j)$. Since the market is oligopolistic, the market deposit rate r_{dj} is a function of bank i 's interest rate r_{dij} and the competitor's interest rate r_{dij-i} ; and the service rate k_j is a function of bank i 's service rate k_{ij} and the competitor's service rate k_{ij-i} . In region j , bank i has to take into account not only the market equilibrium interest rate on deposits r_{dj} (which is determined by the deposit rates of bank i and its competitors), but also the effect of the market service charge rate k_j (k_{ij}, k_{ij-i}) (which is jointly determined by the service charge rates of bank i and its competitors) on the total amount of deposits absorbed $D_j = D_{ij} + D_{ij-i}$, and thus the deposit supply function for region j is $D_j(r_{dj}, k_j)$. In addition, we can define the demand function for bank intermediation services as $T_j(k_j, r_{dj})$, implying that bank i in region j also has to take into account the effect of the above factors on the demand for bank intermediation services $T_j = T_{ij} + T_{ij-i}$. Given the above assumptions, the deposit interest rate and the service fee rate of bank i in region j can be determined by the inverse demand function of the market demand for deposit absorption and service demand in region j , respectively.

$$r_{dj} = P(D_j, k_j) \tag{2}$$

$$k_j = Q(T_j, r_{dj}) \tag{3}$$

$$D_{ij} = D_j \quad T_{ij} = T_j$$

$$k_j/T_j < 0, r_{dj}/D_j > 0; k_j/r_{dj} > 0, r_{dj}/k_j > 0$$

The first two partial derivatives denote a downward-sloping service demand curve and an upward sloping supply curve for deposits. The last two partial derivatives represent the complementary relationship between the service charge rate and the deposit rate, where an increase (decrease) in the deposit rate leads to an increase (decrease) in the service charge rate. This complementary relationship is due to the increase in the service charge rate causes depositors to reduce the demand for bank services thus mobilizing the volume of deposits will fall, in order to keep the volume of deposits unchanged the bank must increase the deposit rate in order to absorb the deposits; and deposit interest rate increases lead to an increase in deposits and thus bring an increase in the demand for services, in the supply of services remains unchanged, it is inevitable to make the service charge rate increase, and vice versa. Thus banks can absorb deposits either by paying interest rates on deposits or by subsidizing intermediate banking services.

Bank i 's lending rate is determined by the banking sector's inverse demand function for loans:

$$r_l = L(D) + \varepsilon \partial r_l / \partial D < 0 \tag{4}$$

where ε is a random term for the lending rate. Eq. (4) shows that the deposits of each bank in the segmented regional markets are absorbed, while loans are made to face the national market. A bank's supply of loans is a certain percentage of the total deposits absorbed by the bank, usually this percentage is between 0 and 1. In this paper, this percentage is set to 1 for simplicity and without prejudice to the conclusions of the analysis.

The lending rate is then determined by the amount of loanable funds D available in the country and the demand for loans $D (r_l + \varepsilon)$, and the lending rate is a decreasing function of the amount of deposits D . Because banks face uncertainty associated with deposit liquidity, loan delays, and monetary policy changes, equation (4) includes a random term ε for the change in the lending rate, which we assume has a mean of 0 and variance of σ^2 .

The total cost function for bank i 's deposit and loan operations and intermediation in region j is given by:

$$C_{ij} = C(D_{ij}, T_{ij}), \frac{\partial C_{ij}}{\partial D_{ij}} > 0; \frac{\partial C_{ij}}{\partial T_{ij}} > 0; \frac{\partial C_{ij}}{\partial D_{ij} T_{ij}} \leq 0 \tag{5}$$

The first two partial derivatives indicate that the total cost function is an increasing function of deposit-taking and intermediate service provision, while the last negative partial derivative indicates that there are economies of scope in the provision of deposits and loans and intermediation, i.e., that engaging in both types of business reduces costs.

Combining the above equations, the profit function for bank i can be expressed as:

$$\pi_{ij} = (r_l - r_{dj})D_{ij} + k_j T_{ij} - C_{ij}(D_{ij}, T_{ij}) \tag{6}$$

The profit-maximizing condition for bank i with respect to deposit taking and service volume provision is:

$$\frac{\partial \pi_{ij}}{\partial D_{ij}} = 0; \frac{\partial \pi_{ij}}{\partial T_{ij}} = 0 \tag{7}$$

Combined Condition (7) with equations (2), (3), (4) and (6), the marginal output optimization condition for deposits of bank i in region j is as follows:

$$r_l - r_{dj} = \frac{\partial C_{ij}}{\partial D_{ij}} - D_{ij} \frac{\partial r_l}{\partial D} \frac{\partial D}{\partial D_{ij}} + D_{ij} \frac{\partial r_{dj}}{\partial D_j} \frac{\partial D_j}{\partial D_{ij}} \left(1 - \frac{\partial k_j}{\partial r_{dj}} \frac{T_{ij}}{D_{ij}} \right) + \lambda_{ij} D_{ij} \sigma^2 \tag{8}$$

$$k_j = \frac{\partial C_{ij}}{\partial T_{ij}} - \frac{\partial k_j}{\partial T_j} \frac{\partial T_j}{\partial T_{ij}} T_{ij} \left(1 - \frac{\partial r_{dj}}{\partial k_j} \frac{D_{ij}}{T_{ij}} \right) \tag{9}$$

λ_{ij} is the Arrow-Pratt absolute risk aversion coefficient.

We can use equations (8) and (9) as the average service charge rate and deposit/loan spread conditions for the banking sector to maximize profits in region j , and adjust them in conjunction with equation (1). We obtain:

$$r_l - r_{dj} = \frac{\partial C_{ij}}{\partial D_{ij}} - D \frac{\partial r_l}{\partial D} + D_j \frac{\partial r_{dj}}{\partial D_j} \left(1 - \frac{\partial k_j}{\partial r_{dj}} \frac{T_{ij}}{D_{ij}} \right) + \lambda_{ij} D_{ij} \sigma^2 \tag{10}$$

$$k_j = \frac{\partial C_{ij}}{\partial T_{ij}} - \frac{\partial k_j}{\partial T_j} \frac{\partial T_j}{\partial T_{ij}} T_{ij} \left(1 - \frac{\partial r_{dj}}{\partial k_j} \frac{D_{ij}}{T_{ij}} \right) \tag{11}$$

Accordingly, we can analyze the impact of bank market structure on the profit maximization conditions in the banking sector. In equation (10), the first term on the right-hand side of the equation is the effect of the cost of deposit and loan operations on the deposit and loan spreads, the second term is the effect of the monopoly power in the market for loan supply, the third term is the effect of the monopoly power in the deposit market and the fourth term is the effect of risk. In equation (11), the first term on the right is the effect of intermediation costs on service charge rates, and the second term is the effect of monopoly power in the deposit market. Eq. (11) shows that for a given service

rate and deposit rate $\partial r_{dj}/\partial k_j$, the larger deposit service rate D_{ij}/T_{ij} , the smaller the profit-maximizing service charge rate k_j is. And as D_{ij}/T_{ij} increases, it can be seen from equation (10) that the deposit and loan spread widens. Under the condition that the loan interest rate is certain, the decrease in the deposit rate r_{dj} raises profits and compensates for the decrease in the service charge rate. The extent to which deposit rates are lowered and service charges are compensated depends on the effectiveness of price discrimination between the two types of depositors (those who receive interest income on their deposits and those who receive financial services).

In addition, the more deposits are mobilized per unit of service charge, i.e. the larger the D_{ij}/T_{ij} the greater the willingness of the bank to reduce the service charge rate as an alternative strategy to deposit mobilization in order to maximize profits. This is because in this case, the bank can reduce its interest expense $r_{dj}D_{ij}$. Thus, we can see that a reduction in the interest rate does not imply that the bank's ability to mobilize deposits is reduced. Banks can increase their deposit-taking capacity by offering cheap intermediate services. Thus, the market monopoly power of deposit taking can thus indirectly maximize bank profits by switching between the two ways of taking deposits: if the state regulates interest rates, then in this process, banks can utilize this switch to promote the development of intermediary business and financial deepening.

Equations (10) and (11) also show that for the banking sector, the bank's monopoly power in the deposit market (including the monopoly power over deposits) is a major factor in the development of the banking industry. The increase in banks' monopoly power in the deposit market (both for deposits and loans and for the provision of intermediary services) can increase deposit and loan spreads and service charge rates without affecting deposit-taking. The above analysis shows that the market structure factors of banks have a significant impact on the amount of deposit taking and service provision as well as the determination of deposit interest rate and service fee rate to maximize the profit of the banking industry, suggesting that banks' utilization of these market structure factors may open up new avenues for financial deepening.

3. Discussion

From the above analysis, we can see that market structure factors have a very important impact on the behavioral choices of commercial banks to achieve profits. When studying the financial deepening of developing countries, we cannot simply analyze the impact of deposit interest rate on financial deepening as we do in the theory of financial liberalization, nor can we analyze the impact of banks' operating costs on resources in the same way as a simple marginal interest rate analysis of financial deepening. We must consider the impact of various market structure factors such as the expansion of intermediate services and market monopoly power. The IMF study shows that structural factors in the US deposit market explain 92% of the level of commercial bank deposits, but the effect of monopoly power would be much lower if not taken into account. Eichberger and Harper show that when the market structure is oligopolistic and commercial bank products are completely different from those of non-bank financial institutions, interest rate ceilings ensure that a constrained cartel rate promotes financial deepening [6]. However, substitutability between commercial bank products and those offered by Nonbank Financial Institutions (NBFIs) reduces the market monopoly power of the commercial bank cartel. In this case, the deposit interest rate cap clearly contributes to reducing competition among commercial banks while at the same time limiting their power to respond to price competition from NBFIs. These empirical findings, although based on developed countries, suggest that for developing countries, the existence of bank monopolies and stronger interest rate controls should make it important to consider market structure factors in choosing the right path to financial deepening.

In summary, for developing countries, if financial deepening is promoted through higher interest rates on deposits, as advocated by the financial liberalization thesis, the potential for using intermediary services and market monopoly power to promote financial deepening may be lost [7, 8]. Considering the impact of market structure factors on financial deepening, then a highly concentrated

banking sector and interest rate regulation may be necessary for developing countries to promote financial deepening, and commercial banks can contribute to financial deepening through, for example, increased branching and intermediation services. It should be noted, however, that while interest rate controls are not necessarily detrimental to financial deepening, the monetary policy adopted must be conducive to reducing inflation and avoiding negative real deposits, because high inflation and negative real interest rates can frustrate banks' efforts to promote financial deepening through non-interest rate means.

4. Summary

Whether in favor of or against financial liberalization or financial constraints to promote financial deepening, what they have in common is that commercial banks are the main body of the financial market in developing countries, and emphasize the importance of interest rate factors in the process of financial deepening. However, most of these theories have ignored the structural factors of banking markets in developing countries and do not include intermediation by banks in the systematic study of financial institutions. In this paper, we will analyze the profit maximization conditions of commercial banks by introducing intermediary services in banking under the assumption of oligopoly in the banking market and show that developing countries can absorb deposits, maximize profits and promote financial deepening through market monopoly power and the development of intermediary bank services without necessarily relying on interest rate marketization. We must consider the impact of various market structure factors such as the expansion of intermediate services and market monopoly power.

References

- [1] McKinnon, Ronald I., *Money and capital in economic development*. Washington, D. C., The Brookings Institution, 1973.
- [2] Edward S. Shaw. *Financial deepening in economic development*. Oxford University Press, New York, 1973.
- [3] Boris Nikolov, Lukas Schmid, Roberto Steri. *The Sources of Financing Constraints*. *Journal of Financial Economics*, 2021, 139(2): 478-501.
- [4] Hellmann, Thomas, Kevin Murdock, and Joseph Stiglitz. *Financial Restraint: Toward a New Paradigm*, in Masahiko Aoki, Hyung-Ki Kim, and Masahiro Okuno-Fujiwara (eds), *The Role of Government in East Asian Economic Development: Comparative Institutional Analysis*, Oxford, 1998.
- [5] Pierre Chiappori, David Perez-Castrillo, Thierry Verdier. *Spatial competition in the banking system: Localization, cross subsidies and the regulation of deposit rates*. *European Economic Review*, 1995, 39, (5): 889-918.
- [6] Jürgen Eichberger, Ian R Harper. *On Deposit Interest Rate Regulation and Deregulation*. *Journal of Industrial Economics*, 1989, 38, (1):19-30.
- [7] Liu, Zheng, Pengfei Wang, and Zhiwei Xu. *Interest Rate Liberalization and Capital Misallocations*. *American Economic Journal: Macroeconomics*, 2021, 13 (2): 373-419.
- [8] Tarhan Feyzioglu, Nathan Porter, Elöd Takáts. *Interest Rate Liberalization in China*. IMF working paper, 2009.