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인플레이션이 銀行의 財務構造와 資產危險度에 미치는 影響
〈국문요약〉

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기업의 재무구조와 인플레이션과의 관계는 세율에 대한 다양한 형태의 가정을 통하여 연구, 분석되어 왔으나, 이 문제를 확실히 해결하지는 못하였다. 근자에 A. Marcus(1983)가 미국의 은행의 재무구조를 대상으로 한 시계열분석 결과에 의하면 명목이자율의 상승이 미국은행의 부채 대비 자본금 비율을 하락시키는 절대적 요인이 되었다고 한다.

본 연구의 목적은 인플레이션과 은행의 부채 대비 자본금 비율의 상관관계, 더욱 나아가서 은행자산의 위험도가 이 상관관계에 미치는 영향을 분석코자 한다.

본고는 은행규제기관(FDIC 등)의 부채비율과 은행자산(포트폴리오)의 위험도에 대한 규제하에서 은행이 부채(예금)와 자본금의 가치를 극대화하고자 하는 모델을 설정하여 기대 인플레이션 수준이 은행의 적정 자본비율과 자산의 위험도와 어떤 관계가 있는가를 밀러의 균형모델(Miller Equilibrium Model)을 원용하여 분석하였다. 밀러의 균형모델하에서는 기업의 재무구조는 기업가치와 무관한 것으로 나타나고 있다. 즉, 부채를 통한 자금조달에 의해 발생되는 한계세금혜택은 균형하에서는 사라진다는 이론이다. 따라서 인플레이션은 적정 재무구조에는 영향을 미치지 못하게 된다. 왜냐하면 인플레이션은 기업의 세후 부채조달비용과 회사채 투자자 수익에 동일한 영향을 미치기 때문이다.

그러나 은행의 경우 일반 기업과는 달리 은행규제기관의 부채비율 및 자산위험도에 대한 규제압력이 소위 암묵적 규제비용으로 작용하여 은행의 적정자본금비율은 부채(예금)를 통한 자금조달의 한계세금혜택과 이에 따른 한계규제바용이 동일하게 되는 경우에 결정된다.

밀러의 단순균형 모델하에서 한계세금혜택이 없는 것과는 달리 은행의 부채조달에 따른 한계규제비용이 존재하는 이유로 균형조건으로 한계세금이익이 존재하게 된다. 이 경우 인플레이션은 예금자의 실질 세후 예금이자를 상승시키는 것 이상으로 은행의 실질 세후 예금이자 지급비용을 하락시키게 되어 은행의 부채비율을 더욱 높이게 되는 원인이 된다.

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또한 은행의 부채비율이 인플레이션과 정(正)의 관계에 있다면 은행규제의 강도에 따라 이 상관계수는 은행자산의 위험도와도 역시 정(正)의 관계에 있게 된다.

미국은행을 대상으로 한 회귀분석에서도 그들의 부채(예금)비율이 기대 인플레이션과 정(正)의 상관관계가 있음이 나타났고 그 상관계수는 은행자산의 위험도와 동일 방향으로 움직임이 판명되었다.

The Inflation Effect on Optimal Bank Capital Structure and Asset Riskiness

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I . Introduction

Some of the important consequences of inflation arise from inflation induced distortions in the real tax rates on corporate and personal income, since tax rates are not indexed. Hamada(1979) points out that corporate capital structures may be affected by inflation because part of nominal debt interest payments are tax-deductible even though they are actually repayments of principal. Feldstein, Green and Sheshinski (1978) analyze the relationship between the inflation rate and debt to equity ratio assuming an uniform personal tax rate on both interest and dividend income. They show that inflation rate change is positively related to both the debt to equity ratio and the equity return of firms which make their financing decisions to minimize the cost of capital.[1] Modigliani(1982) also shows positive inflation impact on the value of leve-

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1) However, their assumptions are inconsistent with modern capitaltheory since if debt and dividend income are taxed identically at the personal level, the tax deductibility of indterst at the corporate level makes debt the preferred financing tool.

rage.

In contrast to the work of Feldstein, Green and Sheshinski(1978), Schall(1984) demonstrates that we can have quite opposite results. He uses the terms "Gain and Loss Effect"(GLE) and "Interest Effect"(IE) to refer to the tax distortions introduced by using nominal rather than real gains and losses to shareholders and by using nominal rather than real interest in tax computations for debt holders, respectively. Under simplifying assumptions, it is shown that IE will encourage less borrowing in the economy and will dominate GLE(which motivates more borrowing by increasing equity taxes), the net impact being an inflation-induced tax incentives to decrease debt relative to equity.[2] Taggart(1984) shows positive inflation effect on corporate leverage, combining Miller's model and the agency cost model. Other related works are Nelson (1976), Jaffee(1978), Cross(1980) and Hochman and Palman(1983), etc. While these studies in corporate finance have not resolved the subject issue, it seems worthwhile to analyze the implication of the inflation related corporate financial studies for commercial banks.

Recently, Marcus(1983) has done an empirical study about bank capital ratios during the last two decades. He finds that the rise in nominal interest rates during this period has contributed substantially to the fall in bank capital ratios. He argues that if banks pay competitive rates for deposits, then the present value of the stream of tax savings for issuing deposits is unaffected by changes in interest rate. In contrast, bankruptcy and regulatory costs imposed by the regulators(FDIC hereafter) are assumed to be independent of the interest rate. Therefore, increases in the interest rate lower the present value of the these costs and disturb the marginal balance between regulatory costs and the tax advantages of deposit finance. The induced substitution of deposits for equity lowers the equilibrium ratio of equity to assets. The recent sharp decrease in bank capital ratio, however, has been mainly understood as a reaction to the relaxation of FDIC regulation, such as increasing deposit rate ceilings, allowing various kinds of funding methods(liability management) and flat rate of deposit insurance premium. The conceivably inflation-related empirical findings in Marcus'

2) However, in general(i.e., assuming no constraints on tax rates, changes in real pre-tax returns on assets caused by inflation, on noninterest debt costs, etc.), the effects of GLE and IE are more complex and their net impact may be to increase or decrease the level of corporate debt-equity ratios.

study is an actual motivation of this paper and we are to explore whether and how inflation factors have an effect on determining bank capital structures and bank asset portfolio riskiness under the current tax system and the regulatory banking environment in the U.S.

A model is developed which characterizes the optimal bank capital structures and asset riskiness through an application of the Miller(1977) Equilibrium model to the banking situation. Banks are under the regulatory dominion of the FDIC, which imposes regulatory costs on the bank as a condition for receiving FDIC deposit insurance which induces more deposit financing. With the existence of these two offsetting effects we have a non-zero marginal tax advantage in equilibrium in contrast to the zero marginal tax advantage in the simple version of Miller's model where inflation has no effect on debt financing. This deviation from Miller's equilibrium results in various effects of inflation on the deposit level and asset riskiness. The model is presented in Section 2 for risk neutral investors' case. The risk averse investors' case is well presented by McDonald(1983). Empirical tests follow in section 3, and section 4 concludes.

II. The Model

The determination of an optimal bank capital structure has been studied by numerous scholars theoretically and empirically. But the underlying issue has not yet been resolved. Empirically, Peltzman(1970) directly estimates the magnitude of the effect of government regulation on capital investment in commercial banking. Mayne(1972) analyzes differences in the amount of capital funds held by banks in each of the examination classes(national, state Federal Reserve member, and nonmember banks). Both findings are consistent in that regulations do not have a significant effect on the capital structure of commercial bank. Mingo(1975), however, offers new evidence that indicates, contrary to the earlier findings, that regulations significantly influence banks' capital decision.

Santomero and Watson(1977) provide the model which presents the two offsetting elements in banks' capital adequacy question, viz., the costs assciated with bank failures that result from the industry being insufficiently capitalized, and the costs that forces over-capitalization imposed on both the bank and on society as a whole. They show that a socially optimal capital requirement can be uniquely determined. Taggart and Greenbaum(1978) get an interior optimal capital structure using the reserve requirement and transaction service profit which is complementary with deposits as a counter-balancing factor. Buser,Chen and Kane(1981) argue that optimal bank capital is determined by a tradeoff between tax savings and the implicit costs of regulatory interference of FDIC. Orgler and Taggart(1983) apply the Miller equilibrium model to the bank capital structure, incorporating the transaction and liquidity service provided to depositors and its cost incurred to the bank.

We take the view that banks are corporations and are thus susceptible to corporate capital structure theory, which enables us to apply the Miller Equilibrium concept to the bank structure. Since Miller's argument plays an important role in our analysis, it is useful to review its essential features. It is well summarized in Orgler and Taggart(1983) as follows. To take the simplest version of Miller's model, consider a world of certainty in which investors choose among corporate bonds, paying an interest rate r, tax-exempt bonds, paying an interest r^{o}, and corporate stock. Investors pay taxes on income from corporate bonds at the rate θ^{n}, where θ^{n} may differ across individuals in different tax brackets. Income from corporate stock, on the other hand, like that from tax-exempt bonds, is assumed to be free of personal taxes. In addition, corporations pay taxes on profits at the rate τ.

If a corporation retires a dollar of debt it saves r in interest payments, so that $r(1-\tau)$ can be channeled (after taxes) to its shareholders. Since shares are tax-exempt, the opportunity cost of income from shares is r^{o}, and shareholder wealth would be unchanged by this operation as long as $r(1-\tau)=r^{o}$. Value-maximizing firm will thus have a perfectly elastic supply of debt at the interest rate level $r=r^{o}/(1-\tau)$, because debt and equity can be freely substituted for one another at this level without affecting the firms' market values.

The aggregate demand for corporate bonds by investors, on the other hand, will rise with r. As long as tax arbitrage operations are prohibited, firms as a whold will be able to sell more bonds only by driving up interest rates sufficiently to coax investors in successively higher tax brackets to hold them. The aggregate amount of corporate debt is the level of debt sufficient to drive the interest rate on corporate bonds up to $r^{\circ}/(1-\tau)$. Once that aggregate amount of debt has been issued, however, any individual firm will be indifferent to further changes in its capital structure.

In Miller's model, inflation leaves optimal leverage unchanged because the tax advantage to debt finance vanishes in equilibrium. When the inflation rate changes, it affects the after-tax costs to borrowing and returns to lending in the same way, and thus has no effect, because there is no marginal tax advantage to debt.

With Miller's model of corporate capital structure in mind, we now turn to the capital decision in commercial banks. In contrast to the case of corporations, banks are under the regulatory pressure by FDIC as a condition for receiving deposit insurance. The provision of deposit insurance increases the value of deposits, which results in more deposit financing. On the other hand, the regulatory pressure such as capital requirements, reserve requirements, limitation of portfolio choice and even loss of banking charter or deposit insurance in the worst case, costs the bank. This regulatory pressure is well documented in Buser, Chen and Kane(1981), where they describe how the regulatory costs reduce the bank's incentive to substitute deposit debt for equity capital, since increased leverage increases the expected costs of being discovered either to be insolvent or to have inadequate capital. It has been widely recognized that the availability of deposit insurance at a flat fee that does not vary with the bank's asset riskiness will exacerbate the perverse incentive problems associated with highly levered banks. They argue, however, that the FDIC's regulatory authority, and in particular its ability to deprive a bank of future profits inherent in its charter, acts as an implicit risk-related deposit insurance premium. Optimal bank capital is determined, therefore, by a tradeoff between tax savings for issuing deposits and the implicit regulatory costs.

The existence of regulatory structure presupposes that debt instruments are risk bearing. Thus, under uncertainty, r° can be regarded as the certainty-equivalent rate of return on tax-exempt securities which is assumed to be the same as the return on equity (Barnea, Haugen and Senbet(1981)). With identical certainty equivalent yields, debt and equity are perfect substitutes for one another and this perfect substitutability between debt and equity is also possible under the risk neutrality assumption(Kim(1982) and DeAngelo and Masulis(1980)).

Assume the world of uncertainty and risk neutrality. Commercial banks finance themselves by issuing either equity or a single type of deposit(savings deposit). As in

Miller's model, banks pay corporate taxes at the rate of τ and the return to their equity holders is same as the return of the tax-exempt bond r°. The return to depositors r is taxable at the personal rate θ^{n} where superscript ^{n} indexes the tax bracket of depositors. We assume away regulation Q or one can think that r consists of the explicit interest payment to depositors and the service bank provides. To focus on the tradeoff between deposits and equity holdings, investors are assumed to choose between corporate(or bank) equity and bank deposits.[3]

With an inflation rate π, depositors are taxed at a rate θ^{n} on their nominal return $r+\pi$ on deposits and experience inflation-produced capital losses at an inflation rate which are uncompensated by the tax system. Therefore, the real after tax return on deposits equals

$$(r+\pi)(1-\theta^{n})-\pi = r(1-\theta^{n})-\theta^{n}\pi$$

Inflation is assumed to be fully anticipated and there is no tax arbitrage.

For the equity holders, inflation raises the nominal value of the banking firm's equity capital at rate π. If the value of the deposits is assumed to be fixed in nominal terms, all of this increase in the nominal value of the banking firm's equity capital accrues to equity holders. Without capital gains tax, the real net-of-tax return on equity equals r°.[4] Thus, we have in equilibrium :

$$r(1-\theta^{*}) - \theta^{*}\pi = r^{\circ} \qquad (2-1)$$

where θ^{*} represents the marginal tax bracket and thus all investors in the tax brackets lower than θ^{*} are deposit holders and those in tax brackets greater than θ^{*} are equity holders.

Consider a competitive banking industry where every bank is assumed to be identi-

3) In the more realistic situation, the demand for depositors should reflect the availability of corporate bonds and other investment vehicles as well. Our analysis may be thought of as a model of equilibrium in the banking industry that is implicitly imbedded on a general equilibrium model(Orgler and Taggart(1983)).

4) This so-called "Super Fisher effect" is also discussed by Gandoffi(1982) and Modigliani(19 82).

cal.[5] The bank's portfolio one period from now generates a real cash flow Y net of total capital(equity plus deposits), which is assumed to be uniformly distributed on the interval $[y-k(y),\ y+k(y)]$ where k represents the asset riskiness which is an increasing function of the expected net cash flow y, i.e., $k'(y) > 0$ (Chan and Mak (1980)). The total capital (equity plus deposits) is assumed to be fixed at the beginning of a period.

As described earlier, depositors are paid a nominal return of $r+\pi$, which is a tax-deductible expense for the bank. The real, after tax cost of deposit interest is thus:

$$(r-\pi)(1-\tau)-\pi=r(1-\tau)-\tau\pi$$

After corporate taxes, the expected net real income available to equity holders is given by :

$$\int_{Y^*}^{y+k}[(1-\tau)Y-\{r(1-\tau)-\tau\pi\}D]f(Y)dY$$

where Y^* represents the level of cash flow which gives zero net real income to equity holders and equals $\frac{[r(1-\tau)-\tau\pi]D}{1-\tau}$, and f( ) is the density of Y which equals 1/2k.

The expected return on equity, which is assumed to equal the return on tax-exempt securities r°, is :

$$r^\circ=\int_{Y^*}^{y+k}\frac{[(1-\tau)Y-\{r(1-\tau)-\tau\pi\}D]f(Y)dY}{E} \qquad (2-2)$$

where E is the amount of equity.

From (2-1), the demand for deposits is given by :

5) By competitive banking industry we mean that the bank's capital structure change does not *effect* θ^*.

$$r = \frac{r^{\circ} + \theta^{*}\pi}{1-\theta^{*}}$$

Thus, the market value of the bank is :

$$V=E+D=\frac{1}{r^{\circ}}\left[\int_{Y^*}^{y+k}\left[(1-\tau)Y-\left\{\frac{r^{\circ}(1-\tau)+\pi(\theta^{*}-\tau)}{1-\theta^{*}}\right\}D\right] f(Y)dY+D \right. \quad (2-3)$$

Note that the value of debt equals D due to deposit insurance.[6]

Hence, the bank under FDIC's regulatory pressure solves :

$$\max_{D,\, y} V$$

$$\text{s. t.} \quad U(D, y) \geq U^{\circ} \quad (2-4)$$

where U and U° are the FDIC's utility function and the reservation utility, respectively. It is assumed that $\frac{\partial U}{\partial D} < 0$ and $\frac{\partial U}{\partial y} < 0$.

The Lagrangian for the bank's problem becomes

$$L = V+\lambda(U-U^{\circ})$$

$$=\frac{1}{r^{\circ}}\left[\int_{Y^*}^{y+k}\left[(1-\tau)Y-\left\{\frac{r^{\circ}(1-\tau)+\pi(\theta^{*}-\tau)}{1-\theta^{*}}\right\}D\right]f(Y)dY\right] +D+\lambda(U-U^{\circ}) \quad (2-5)$$

where λ is the multiplier for the constraint.

The first order conditions are :

$$L_D = \frac{1}{r^{\circ}}\left[\int_{Y^*}^{y+k} f(Y)dY \left\{\frac{(r^{\circ}+\pi)\ (\tau-\theta^{*})}{1-\theta^{*}}\right\}\right] + \int_{Y^*}^{y+k} f(Y)dY + \lambda U_D$$

$$= \frac{1}{2r^{\circ}k}\left[(y+k-Y^{*})\left\{\frac{(r^{\circ}+\pi)\ (\tau-\theta^{*})}{1-\theta^{*}}\right\}\right] + \frac{Y^{*}-y+k}{2k} + \lambda U_D$$

$$= 0 \quad (2-6)$$

6) Since deposit insurance premium is not dependent of the asset riskiness, the assumption of free insurance does not alter the thrust of the analysis.

Note that $(Y^*-y+k)/2k$ represents the marginal increase in V due the the deposit insurance, without which it vanishes. Thus the sum of $(Y^*-y+k)/2k$ and λU_D represents the marginal net regulatory costs imposed on banks by FDIC. If the marginal net regulatory costs are positive, there exists positive tax advantage (i.e., $\tau > \theta^*$) in equilibrium so that the marginal corporate tax advantage exactly offsets the marginal regulatory costs on deposit financing. And we have :

$$L_Y = \frac{1-\tau}{4r^o k^2}(y+k-Y^*)\ [2k+k'(k-y+Y^*)] + \lambda U_Y = 0 \tag{2-7}$$

We can see $L_Y > 0$ without U_Y, which implies that banks tend to choose riskier asset without regulatory pressure. Finally, we have binding constraint as :

$$L_Y = U-U^o = 0 \text{ and } \lambda^* > 0 \tag{2-8}$$

Totally differentiating the first order conditions (2-6), (2-7) and (2-8) with respect to D, y and λ and the predetermined π yields :

$$\begin{bmatrix} V_{DD}+\lambda U_{DD} & V_{DY}+\lambda U_{DY} & U_D \\ V_{yD}+\lambda U_{yD} & V_{yy}+\lambda U_{yy} & U_y \\ U_D & U_y & 0 \end{bmatrix} \begin{bmatrix} d_D \\ dy \\ d_\lambda \end{bmatrix} = -\begin{bmatrix} \frac{\partial V_D}{\partial \pi} \\ \frac{\partial V_y}{\partial \pi} \\ 0 \end{bmatrix} d\pi \tag{2-9}$$

where

$$\frac{\partial V_D}{\partial \pi} = \frac{1}{2r^o k^*}\left(\frac{\tau-\theta^*}{1-\theta^*}\right)\left[\frac{(\tau-\theta^*)D^*}{(1-\tau)\ (1-\theta^*)}(r^o+\pi)+(y^*+k^*-Y^*)\right]$$
$$-\frac{D^*}{2k^*}\left[\frac{\tau-\theta^*}{(1-\tau)\ (1-\theta^*)}\right]$$
$$=\frac{1}{2r^o k^*}\left(\frac{\tau-\theta^*}{1-\theta^*}\right)(y^*+k^*-2Y^*) \tag{2-10}$$

As shown in (2-10), given negative lower bound of Y and $y > Y^*$, the marginal contribution of deposit financing to the bank value increases (decreases) as inflation rate increases if $\tau > (<) \theta^*$.

And, we have

$$\frac{\partial V_y}{\partial \pi} = \frac{D^*}{2r^o k^{*2}} \left(\frac{\tau-\theta^*}{1-\theta^*}\right) (k^* - k'^* y^* + k'^* Y^*) \qquad (2-11)$$

where D^* and y^* represent the optimal value of D and y, and $k^* = k(y^*)$ and $k'^* = k'(y^*)$.

Solving (2-9) for $\frac{dD^*}{d\pi}$ and $\frac{dy^*}{d\pi}$, we have :

$$\frac{dD^*}{d\pi} = \frac{1}{|H|} \left(\frac{\partial V_D}{\partial \pi_D} U_y^{*2} - \frac{\partial V_y}{\partial \pi} U_D^* U_y^*\right) \qquad (2-12)$$

where $|H|$ is the bordered hessian of (2-9) and is assumed to be positive for maximum and

$$\frac{dy^*}{d\pi} = \frac{1}{|H|} \left(-\frac{\partial V_D}{\partial \pi} U_D^* U_y^* + \frac{\partial V_y}{\partial \pi} U_D^{*2}\right) \qquad (2-13)$$

where $U_D^* = U_D(D^*, y^*)$ and $U_y^* = U_y(D^*, y^*)$.

If there is a positive tax advantage to deposit financing in equilibrium ($\tau /> \theta^*$), due to the dominance of the regulatory costs over the deposit insurance benefit, then inflation lowers the real net-of-tax cost by more than it raises the real net-of-tax return on deposit, which results in more deposit financing (see (2-10)). As shown in (2−12), however, the sign of dD/d cannot be determined unambiguously, since the sign of $\partial V_y/\partial \pi$ is undetermined. In order to obtain more insights into the nature of the comparative static results, we solve (2-4) for the closed form solution.

A Closed Form Solution

Assume that U is linear in D and y, and $k = ay$ where a is positive constant such that $|H| > 0$. The the bank solves :

$$\max_{D,\ y} \quad V$$

$$\text{s. t.} \quad vD + wy \geqslant U^{\circ} \tag{2-14}$$

where $v \leqslant 0$, $w \leqslant 0$ and $U^{\circ} < 0$, i. e., the greater U°, the higher the regulatory pressure.

Solving for D^{*} and y, we have

$$D^{*} = \frac{U^{\circ}}{v}[1+wB(\frac{A}{K})^{1/2}] \tag{2-15}$$

$$y^{*} = -U^{\circ}\ B(\frac{A}{K})^{1/2} \tag{2-16}$$

$$\text{where } A = -\frac{1-\tau}{2w}$$

$$B = \frac{r^{\circ}(1-\tau)+\pi(\theta^{*}-\tau)}{(1-\theta^{*})\ (1-\tau)}$$

$$K = v[2ar^{\circ} - B(1-\tau)(1+a)]$$

$$-\frac{W}{2}B^{2}(1-\tau) - \frac{1-\tau}{2w}v^{2}(1+a)^{2}$$

From (2-15) and (2-16), we can see :

$$\frac{\partial D^{*}}{\partial U^{\circ}} < 0 \text{ and } \frac{\partial y^{*}}{\partial U^{\circ}} < 0 \tag{2-17}$$

i.e., as U° increases (more regulatory pressure), the optimal choice of D^{*} and y^{*} decreases.

Also, we have :

$$\frac{\partial D^{*}}{\partial \pi} = U^{\circ}\left[\left(\frac{A}{K}\right)^{1/2}\left(\frac{w}{v}\cdot\frac{\partial B}{\partial \pi} - \frac{B}{2K}\cdot\frac{\partial K}{\partial \pi}\right)\right] \tag{2-18}$$

$$\frac{\partial y^{*}}{\partial \pi} = -U^{\circ}\left[\left(\frac{A}{K}\right)^{1/2}\left(\frac{\partial B}{\partial \pi} - \frac{B}{2K}\cdot\frac{\partial K}{\partial \pi}\right)\right] \tag{2-19}$$

where

$$\frac{\partial B}{\partial \pi} = \frac{\theta^* - \tau}{(1-\theta^*)\ (1-\tau)}$$

$$\frac{\partial K}{\partial \pi} = \left(\frac{\tau - \theta^*}{1-\theta^*}\right) [v(1+a) + wB].$$

Let the whole expression in the big bracket in(2−18) be X, so that $\frac{\partial D^*}{\partial \pi} = U^\circ X$. Then we have :

$$\frac{\partial}{\partial U^\circ}\left(\frac{\partial D^*}{\partial \pi}\right) <(>)\ 0 \qquad \text{if X} \ <(>)\ 0 \qquad (2-20)$$

Together with (2−17) and (2−20), we know that $\frac{\partial D^*}{\partial \pi}$ and y^* move in same (opposite) direction as regulatory pressure U° changes, iff $X < 0$ ($X > 0$) regardless of whether $\tau > \theta^*$ or $\tau < \theta^*$.

Since X <(>) 0 implies $\frac{\partial D^*}{\partial \pi}$ <(>) 0 , we can conclude that if the bank's deposit ratio is positively (negatively) affected by inflation, then the inflation sensitivity of the deposit ratio $\left(\frac{\partial D^*}{\partial \pi}\right)$ increases (decreases) as asset riskiness (y^*) increases. Hence we have the following proposition.

Proposition

If X is < 0(>) 0 , i. e., if the bank's deposit ratio is positively (negatively) affected by expected inflation rate, then the inflation sensitivity of deposit ratio increases (decreases) as asset riskiness increases.

III. Empirical Tests

Recently, Marcus(1983) has done an empirical research about bank capital ratios during 1965−1977. He finds that the rise in nominalinterest rates during this period has contributed substantially to the fall in capital ratios of banks. However, the deficiency of his empirical research is that no specific hypotheses are presented to explain why the effect of interest rate movements on capital ratios should vary as regulatory pressure changes.

Following the proposition in section 2, we examine whether the expected inflation rate has an effect on determination capital ratio of banks and if so, we further examine whether the inflation rate sensitivity of capital ratios is related to the asset risk choice of the banks. According to the proposition, if there exises positive inflation effect on deposit financing (i. e., $X < 0$), the riskier asset is related to the higher inflation sensitivity of deposit ratio.

1. Measuring the Effect of Expected Inflation Rate Changes on Capital ratios.

In order to test whether $X <(>) 0$ in section 2, we estimate the following model to examine whether the expected inflation rate has an effect on determining capital ratios of banks.

Banks are assumed to adjust capital to desired levels with a lag that can be approximated by the partial adjustment model. Based on the expected inflation rate for the next period and the most recent unexpected inflation rate, a target capital ratio for the current period is specified for each bank. Due to costs that would be incurred from frequent issue or retirement of equity, the movement of the actual capital ratio towards the target would not be instantaneous. Rather, the difference between the past and the current capital ratio would be a fraction of the difference between the past and the targeted ratio.

Let C_{jt}^* denote the target capital ratio that the jth bank seeks to obtain for time t. The target is assumed to be a function of the expected inflation rate for time t, the most recent unexpected inflation rate and the interest rate volatility. Thus, we have :

$$C_{jt}^* = \alpha_{oj} + \alpha_1 \, INF_t + \alpha_2 \, UNIF_{t-1} + \alpha_3 \, IV_{t-1} + v_{it} \qquad (3-1)$$

where

C_{jt} = the ratio between the market value of equity and the market value of equity plus the total deposits of the j-th bank at time t.

INF_y = the annualized T-bill return at time t, TB_t, as a proxy for expected inflation rate at time t (Fama and Schwert(1977) which is obtained from Ibbotson Associates (1986).

$UNIF_{t-1}$ = $CPI_{t-1} - TB_{t-1}$, as a proxy for unexpected inflation rate at time t−1 where CPI stands for consumer Price Index.

IV_{t-1} = the variance of the level of the Treasury bill rate for the twelve monthly observations in each year t−1, which measures interest rate risk.

v_{jt} = disturbance term

Let δ denote the speed of adjustment of capital ratio with $0 < \delta < 1$. Then, we have

$$C_{it} - C_{jt-1} = \delta(C_{it}^{*} - C_{jt-1}) \qquad (3-2)$$

Combining (3−2) with (3−1), we have :

$$C_{jt} = \gamma_{oj} + \gamma_1 C_{jt+1} + \gamma_2 INF_t + \gamma_3 UNIF_{t-1} + \gamma_4 IV_{t-1} + \varepsilon_{jt} \qquad (3-3)$$

where γ_{oj} is the time independent individual effect for bank j. Equation(3−3) is estimated using both the fixed and random effects specifications for γ_{oj} (Hausman and Taylor(1981)).[7]

We use the market value of equity rather than the book values since our model incorporates the demand side which fluctuates with the change in market value of equity and given the short maturity of deposits, we use book value of deposits as a proxy for their market value. Only 70 percent of deposits at insured banks are insured, but there is general agreement that FDIC policy is to attempt to takesteps to arrange a purchase-and-assumption of an insolvent bank rather than liquidate its assets

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7) An important benefit from pooling time-series and cross-section data (panel data) is the ability to control for individual-specific effects. RE and RE regressions are discussed in Hausman and Taylor(1981).

and pay off depositors. In this case, even uninsured depositors are protected from losses (Marcus and Shaked (1983)). γ_1 measures the adjustment speed which equals $1-\delta$.

The unexpected inflation rate at $t-1$ is included since expected inflation is related to the past values of unexpected inflation. The market value of capital could be low because of the relation between asset/liability maturity mismatching and the unexpected inflation. γ_3 is thus expected to be negative.

The interest rate volatility is also added since interest rate risk should increase capital ratios because it increases the probability of insolvency for any given capital ratio. γ_4 is thus expected to be positive.

Equation (3−3) is estimated using annual data for the period 1967 to 1984. Annual capital ratios are obtained for a sample of 70 commercial banks from the Bank Compustat tape due to data availability during that period. Table 1 contains the results of estimating equation (3−3). As shown in Table 1, the estimates for both fixed and random effects specifications are presented. In the fixed effect (FE) specification, equation (3−3) is estimated by performing regressionson deviations from group means, i. e., the deviation of each observation on bank j from its mean computed over the 18-year period. This procedure forces each γ_{oj} to fall through the origin. In the random effect (RE) specification, the γ_{oj} are incorporated into the disturbance term. The Hausman(1978) specification test for consistency of the RE estimates is unable to reject that specification at five percent confidence levels. The values for rho reported in Table 1 offer no evidence of serial correlation so that reported t-statistics of the coefficient estimates can be used for hypothesis testing.

The coefficients on the expected inflation rate are negative and significant at the one percent level in both regressions, which are consistent with Marcus'(1983) findings. The coefficients of the unexpected inflation are negative and variance of interest receives positive coefficients as expected. The coefficients on the lagged capital ratio imply that the adjustment coefficients are to which are .142 to .244, which are fairly low for annual data.

The evidence that the capital ratio is negatively affected by expected inflation rate supports that $X < 0$ in section 2.

2. Inflation Rate Sensitivity and the Riskiness of Bank Assets

Given the negative relation between the expected inflation rate and capital ratio, the coefficient of expected inflation rate($-\gamma_2$) should be larger, ceteris paribus, the greater the riskiness of bank portfolio if the proposition holds. To represent this proposition, we write the coefficient of expected inflation for bank j as a function of the asset portfolio riskiness variable, which is denoted by RISK,

$$\gamma_{2jt} = \alpha + \beta \ RISK_{jt} \qquad (3-4)$$

Equation (3−4) can be substituted into (3−3) to allow the sensitivity to expected inflation to vary as the asset riskiness of bank j changes over time :

$$C_{jt} = \gamma_{oj} + \gamma_1 C_{jt-1} + \alpha INF_t + \beta RISK_{jt} * INF_t + \gamma_3 UNIF_{t-1} + \gamma_4 IV_{t-1} + e_{jt} \qquad (3-5)$$

The asset riskiness is measured by several alternative proxies as follows :

A. The U.S. Treasury securities holdings as a fractions of assets : Since these are short-term bills, we can avoid interest rate risk. Since the larger the holdings of T-bills, the less riskier bank assets, estimated β is expected to be positive.

B. The total loan amount as a fraction of assets : It measures the credit risk of bank assets. Due to the data availability, the government guaranteed loans cannot be excluded. Estimated β is expected to be negative.

C. The variance of EBIT ratio to assets : It is computed using previous years' EBITs(current operating earnings before interest and tax) and assets(March(1982)). Thus the testing period is reduced to 10 years(1975 to 1984). Estimated β is expected to be negative.

The results of testing (3−5) are presented in Tables 2 and 3 using panel data regression method.

The proposition says that the sensitivity of capital ratios to expected inflation(γ_2) should be positively related to the T-bill holdings ratio to assets and negatively related to the loan amount ratio to assets and variance of EBIT to assets. As shown in Tables 2 and 3, all the coefficients of our proxies for asset riskiness multiplied by expected inflation rate (estimated β's) have thexpected signs. Thus, the evidence supports the proposition that an increase in the asset riskiness corresponds to the greater inflation rate sensitivity of deposit ratio if X < 0, which implies positive inflation effect on deposit financing.

Ⅳ. Conclusion

Many studies in corporate finance have analyzed the possible relationship between the inflation rate and corporate capital structure under various assumptions on tax rates, which, however, have not resolved the subject issue.

A model is developed in which a representative commercial bank maximizes the value of its deposits and equity, subject to the FDIC's regulatory constraint on the capital ratio and portfolio choice of the bank. The model characterizes the effect of the expected inflation rate on the optimal bank capital structure and asset riskiness through an application of the Miller equilibrium model to the banking situation. It is shown that the positive inflation effect on deposit ratio and the asset riskiness move in the same direction as regulating pressure changes.

An empirical test is done to examine the relationship between the expected inflation rate sensitivity of deposit ratios of commercial banks and asset riskiness. Using a sample of actively traded commercial banks, their deposit ratios and found to be positively correlated with the expected inflation rate changes. The co-movement of deposit ratios and expected inflation rate change is found to be positively related to the asset riskiness of commercial bank.

The result shows that a part of the recent decline in bank capital ratios might be the rational response of value maximizing banks to a changing inflation rate and the decline is accelerated by the individual bank's asset riskiness. Thus, the regulatory policy response should be shaped by such a perspective.

TABLE 1*

(1967 – 1984)

Independent Variable	FE	RE
Constant	–	.021 (8.66)
Lagged Capital Ratio	.756 (43.62)	.858 (68.15)
Expected Inflation	-.120 (-8.51)	-.157 (-6.81)
Unexpected Inflation	-.108 (-6.04)	-.091 (-5.07)
Interest** Volatility	.220 (5.17)	.024 (5.56)
RHO	.106	.069
S. E. of Regression	.0163	.0165
Adjusted R^2	.714	.819

* T-statistics are in parenthesis

** Variance of interest rate is multriplied by 1000 in all regressions in order to scale units for convenient presentation.

TABLE 2*

(1967 – 1984)

Independent	RISK = T-Bills/Assets		RISK = Loan/Assets	
Variable	FE	RE	FE	RE
Constant	–	.019 (8.28)	–	.019 (8.38)
Lagged Capital Ratio	.763 (44.29)	.859 (67.99)	.743 (42.87)	.838 (64.94)
Expected Inflation	-.245 (-9.80)	-.190 (-7.95)	.064 (1.19)	.026 (.57)
$\frac{\text{T-bills}}{\text{Assets}}$ × Exp. Inf.	.800 (4.91)	.554 (4.61)		

Loan/Assets × Exp. Inf.			-.335 (-5.43)	-.237 (-4.80)
Unexpected Inflation	-.101 (-5.63)	-.086 (-4.83)	-.128 (-7.05)	-.106 (-5.87)
Interest Volatility	.220 (5.15)	.236 (5.55)	.208 (4.93)	.227 (5.36)
RHO	.095	.062	.091	.065
S.E. of Regression	.0162	.0163	.0161	.0163
Adjusted R^2	.719	.819	.720	.811

* T-statistics are in parentheses

TABLE 3*

(1967 – 1984)

Independent Variable	RISK = T-Bills/Assets FE	RE
Constant	–	.006 (3.73)
Lagged Capital Ratio	.702 (20.47)	.889 (47.34)
Expected Inflation	.022 (1.42)	.025 (1.60)
Var(EBIT/Assets) × Exp. Inf.	-.040 (-111.48)	-.025 (-111.39)
Unexpected Inflation	-.044 (-3.70)	-.024 (-2.03)
Interest Volatility	.259 (3.24)	.202 (4.32)
RHO	.11	.10
S.E. of Regression	.010	.010
Adjusted R^2	.673	.774

* T-statistics are in parentheses.

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