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Probability, Capital and Risk: Commercial vs. Saving/Mortgage Banks

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Abstract[•]

This study examines the relationships between capital, risk, and profitability in U.S. commercial vs. saving/mortgage banks for the period q4/1994-q2/2003. Within a stylized model we distinguish between two types of projects: (1) Common projects such as mortgages characterized by large pricing costs per dollar of credit and stable probability of default and (2) Unique projects such as large scale loans characterized by small pricing costs per dollar of credit and unstable probability of default. Based on the model, we obtain that for common projects the bank sets aside more capital instead of fully price the loan compared to unique and large projects. The results are tested using 3SLS and panel data with fixed effects. Some of the unequivocal results are consistent with the hypotheses and validate the model.

Keywords: Commercial Banks, Mortgage Banks, Profitability, Capital, Risk

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INTRODUCTION

The three main characteristics of any bank are capital, profitability, and risk. The relations between these variables are usually examined in pairs i.e., between capital and profitability, between capital and risk, and between risk and profitability. Such analyses are only partial and the results—whether on a theoretical or empirical basis—are not always unequivocal. This study depicts the relations among all the three elements by comparing two different types of sectors: commercial vs. saving/mortgage banks. The following is a brief survey of the literature.

The relation between capital and profitability

It is generally accepted (see Berger, 1995; Barth et al., 1998) that the Capital Asset Ratio (hereafter CAR) is negatively correlated with Return On Capital (hereafter ROC). According to this hypothesis, the negative relation is obtained (*ceteris paribus*) in a one-period model where deposit rate is not influenced by bank risks. However, if information is symmetrical between the depositors and the bank i.e., there is market discipline and deposit and stock markets are perfect, a rise in CAR due, for example, to the substitution of equity for debt, should reflect the reduced risk that the bank will fail. In such a case, risk-averse depositors who regard capital as a cushion for absorbing losses will demand lower interest rate on deposits if CAR increases which in turn should increase net income and profitability. On the other hand, an increase in CAR enlarges capital, and thereby reduces profitability (*ceteris paribus*). Thus, an increase in CAR causes an immediate reduction in profitability (a rise in capital in the denominator of ROC) but an eventual increase in profitability (a rise in profit in the numerator of ROC). According to the Expected Bankruptcy Costs Hypothesis (henceforth EBCH), if a bank's level of capital is below the optimum, the expected costs of bankruptcy are relatively high, so that a rise in the capital level reduces the yield required on deposits. Consequently, the increase in net income (the numerator in ROC) will have a greater effect

than the rise in capital (the denominator in ROC), *ceteris paribus*, and altogether we can expect a positive relation between capital and profitability. On the other hand, if a bank's level of capital is above the optimum as perceived by depositors, the increase in capital reduces the interest demanded on deposits, so that the relation between capital and profitability is expected to be negative. In general, EBCH assumes 'market discipline' either for well-capitalized or under-capitalized banks.

According to the Signaling Hypothesis (see Acharya, 1988), managers have 'inside information' regarding future performance. If their salaries include stocks and/or stock options it will be cheaper for a safe bank than for a risky bank to signal expected improved performance in the future by increasing capital today. Therefore, capital entails profitability.

A rise in capital may sometimes increase profitability. This typically happens if it enables the bank to overcome high entry barriers and to gain access to profitable activities such as issuing guarantees and subordinated notes, and acting as an intermediary for financial derivatives (See Stiroh, 2000).

The relation between capital and risk

Several studies on the relation between capital and risk examine the effect of bank capital regulations on asset portfolio. A *negative* relation between capital and risk is expected when the model includes deposit insurance scheme in which the premium is flat, and all deposits are insured i.e., there is no 'market discipline'. In this case, the marginal cost of increasing bank risk and reducing the level of capital is zero. This is because in the view of authorities the insurance premium does not change with risk or capital, and for the insured depositors the interest demanded on their deposits is the same as that on a riskless asset. On the other hand, when the insurance premium is adjusted to risk e.g., including the level of financial leverage, there is less incentive to raise the financial leverage (Osterberg and Thomson, 1989). Several studies have examined the effect of the Basle Accord (1988) regarding the minimum capital

requirements.[1] In general, they found that the requirement to hold capital in accordance with risk caused banks to increase assets risks.

The relation between risk and profitability

Stone (1974), who applied a Two-Index Model in banking[2] found a positive correlation between the yield on bank shares and changes in stock and bond indices (reflecting risk). However, Neuberger (1991) found that the effect results in distinction between large and small banks, and between the early and late 1980s. In a competitive business environment where symmetrical information between the bank and its borrowers prevails, one can expect positive relations between return on capital and risk. This should be the result of risk premium demanded by bank stakeholders (See also Saunders et al., 1990; Shrieves and Dahl, 1992).

Most studies examine the correlation between a single pair of the capital-profitability-risk triangle. This may be a drawback if capital, profitability, and risk are determined simultaneously. The relation between each of the two sides of the triangle has to be specified while the third variable is held constant.

The trade offs between pricing risks and setting capital aside are mainly related to parameters such as regulation, competition, and the type of the credit portfolio. The bank might not fully price the credit portfolio for the following reasons: (a) Cost of data collection for each borrower or project is usually greater than the benefit. A case in point is mortgages or standard loans, (b) The population of borrowers is relatively homogeneous but not correlated, the amount of the loan is not significant by large and the distribution of loans repayment is known, (c) In special instances full pricing of risk (in the form of a high-risk premium) may

[1] See, Kendall and Levonian (1992), Haubrich and Wachtel (1994), and Jacques and Nigro (1994).

[2] See also Booth and Officer (1985) and Flannery and James (1984).

create liquidity difficulties for the borrower, thereby further increasing the risk (see Stiglitz and Weiss, 1981), (d) The risk is not directly connected to the borrower e.g., management or operational risks.

In practice, sometimes banks price risks, in other cases they prefer to set aside capital, and in many cases they do both. A formal banking model taking into consideration all mentioned parameters and the optimal level of total risk and capital is beyond the scope of this paper. However, below we link between profitability, capital, and risk in an *ad hoc* analysis assuming all other parameters being equal. Particularly, we explain why saving/mortgage banks hold more risk adjusted capital and their profitability is lower, compared to commercial banks.

In Section 2 we link profitability, capital, and risk in a simple stylized model. Section 3 discusses the methodology and describes the relevant variables. Section 4 presents the data and the results of the empirical examination using both 3SLS and co-integration methodology. Section 5 concludes the paper.

2. LINKING BANK PROFITABILITY, CAPITAL, AND RISK

Within a stylized model we attempt to answer: when banks price a loan, when they set aside capital, and in what cases they do both. The model's assumptions are the followings:

a) The bank costs including interest payment on deposits and operational costs are constant.

b) The information between the bank and its borrowers is symmetric and the competition among banks is perfect[3].

c) Bank's capital as a function of credit risk as well as interest on credit as a function of the borrowers pricing costs, are constructed such as total credit risk is constant.

d) The bank extends one USD of credit, which is divided between two sectors: (1) priced

credit - where the interest on the loan includes risk premium and (2) non-priced credit – where a capital is set aside against the loan's risks.

e) The costs of pricing and monitoring one USD of loan is s where, 1>s>0 and r(s) is the risk-adjusted interest on the loan, pre-determined by the bank. We assume that r(s) is a monotonic increasing function of s. Thus, the larger is the credit risk the higher will be r(s) (all other things being equal).

Based on these assumptions, a bank profit function should be:

(1) $\Pi = [r(s)-s]\alpha + r(0)(1-\alpha) - \beta K(1-\alpha)$

Where,

α is the proportion of the priced credit,

K is bank capital and is an increasing function of 1- α, i.e. the bank sets aside more capital as the proportion of non-priced credit increases.

β represents the bank's cost of capital, and

r(0) is the non-priced interest on credit where the bank prefers to set aside capital.

We assume that: $r(s) > r(0)$, $r'>0$, $r''<0$, $K'>0$, $K''>0$. These assumptions enable the existence of global second order condition in order to get an internal maximum. Taking the derivative of Π with regard to α yields a FOC. By equating the marginal net returns of the two credit alternatives: pricing the risky loan i.e., charging a risk premium vs. setting capital aside we obtain the optimal α that solves the following equality: $r(s) - s = r(0) - \beta K'(1-\alpha)$. A compaprative statistics of α with regard to s yields the result: $\partial\alpha/\partial s > 0$ iff $s_0 > s$ where s_0 solves the equality: $r'(s_0)=1$. The economic interpretation is the following:

1) A bank considers many credit projects.
2) Every project costs s per dollar of credit as a result of pricing and monitoring costs determined by the risk profile of the borrower.

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[3] This assumption means that the interest on credit determined by the bank covers, on average, default expenses in case of bankrupty. Taking into consideration asymmetric information and/or competition level

3) If $s_0 < s$ the bank will price the loan (risk premium). Contrarily, if $s_0 > s$ the bank would tend to set capital aside against potential losses.

Usually, $s_0 > s$ holds for small and unified projects such as mortgages. These projects are relatively small, homogenous, and with a stable the expected rate of default. In contrast, $s_0 < s$ exists in large and heterogeny projects with unstable rate of default. e.g., new and unfamiliar projects to the bank.

The main conjecture from this simple model is that mortgage/saving banks will be characterized by both: more risk-adjusted capital and less profitability compared to commercial banks (all other things being equal). In what follows we test this hypothesis within a context of equations system determining simultaneously bank's profitability and capital given credit risk. Then we test it using co-integration methodology.

3. THE METHODOLOGY

Following Berger (1995) we assume that capital and profitability determined simultaneously, given credit risk (RISK). We measure capital as bank equity to total asset (CAR) and profitability as net income plus loan-loss provision over capital (hereafter BPROC – Before Provision Return On Capital). We focus on BPROC instead of ROC in order to exclude RISK measured in this study as net charge-off to total credit in t-1. Otherwise, ROC that substantially influenced by the latter and RISK could multicolinear.[4] We expect to have the following impact of the parameters on CAR and BPROC for commercial banks:

$$\text{(2a)} \qquad \begin{aligned} \underset{}{\text{CAR}} &= f(\underset{-}{\text{BPROC}},\ \underset{?}{\text{RISK}},\ \underset{+/-}{\text{A}}) \\ \underset{}{\text{BPROC}} &= g(\underset{-}{\text{CAR}},\ \underset{+}{\text{RISK}},\ \underset{+/-}{\text{B}}) \end{aligned}$$

and on CAR and BPROC for saving/mortgage banks:

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among banks is beyond the scope of this simple model.

[4] We test net charge-off in the last quarter (t-1) as a measure for RISK in the current quarter (t) since, it is more exogenous to the bank compared with loan-loss provisions, for example, and usually is determined after the credit loss event. Using other measures, however, did not change the results, qualitatively.

$$
\begin{aligned}
&\text{CAR} = f(\text{BPROC}, \ \text{RISK}, \ \ \text{A}) \\
&\qquad\quad\ \ - \qquad + \qquad +/- \\
&\text{BPROC} = g(\text{CAR}, \ \text{RISK}, \ \ \text{B}) \\
&\qquad\quad\ \ - \qquad ? \qquad +/-
\end{aligned}
\tag{2b}
$$

Where, A and B are vectors of exogenous variables that affect CAR and BPROC, respectively. Within the context of (2) and the assumptions above we assume that credit risks are determined by bank specialization (saving/mortgage vs. commercial) thus, RISK is exogenous to the particular bank in a specific year. Otherwise we would have to include additional equation in the system in order to solve simultaneously for CAR, BPROC, and RISK. Following Berger (1995) we conjecture that BPROC and CAR negatively affect one each other. However, The influence of RISK on CAR and BPROC depends on the type of the bank. For commercial banks, RISK supose to positively affect BPROC as $s > s_0$ i.e., the bank should price the loan (risk premium). For saving/mortgage banks, however, CAR is positively influenced by s ($s < s_0$) as the bank sets capital aside instead of pricing the loan. As exogenous variables (A/B in equations 2a/2b) we choose, the log of U.S. GDP (hereafter GDP) and short run interest rates (hereafter Tbill). By our epectations GDP should positively affect CAR and BPROC of both banking sectors. In boom periods, for example, we evidence either more profitability or less realized credit losses. Contrarly, Tbill should positively influence BPROC (see Demirguc-Kunt and Huizinga, 1999) and negatively CAR as high interest rate level increases the opportunity cost of capital holdings. Note that CAR and BPROC in (2) are influenced mainly by exogenous variables: RISK, GDP, Tbill, and s, reflecting the bank type i.e., commercial vs. saving/mortgage. Thus, we test our hypothesis by comparing the influence of risk on CAR and BPROC for the two banking sectors controlling for GDP and Tbill.

4. THE DATA

The database consists of two types of U.S. banks for the period q4/1994–q2/2003 (35 observations). The two types are commercial banks (7,887 institutions in 2002) and mortgage/saving banks (1,467 institutions in 2002). All banks are insured by the Federal Deposit Insurance Corporation (FDIC) either through the Bank Insurance Fund (BIF) or through the Savings Association Insurance Fund (SAIF). Commercial banks sector includes National banks, State-chartered banks and depository trust companies while Saving/Mortgage banks category include savings banks and savings and loan institutions supervised by the Office of Thrift Supervision (OTS). The quarterly data on banks obtained from the FDIC's web site and is based on Quarterly Call Reports. The advantage of the database is its reliability, consistency, and the lack of sample biases as it contains all insured banks.

Additionally to BPROC, other measures for profitability are: Return On Capital (ROC), Net Interest Margin (NIM) and Interest On Credit (IOC). The indices we use interchangeably as candidates for RISK are: net charge-offs to total credit (RISK), loan-loss provision to total credit (PROV), and problem loans (non performing assets to total assets - NONPER). Another measure for risk is the diversification of the credit portfolio as measured by principal industry. We use the Herfindahll-Hirschmann (H) index for concentration based on 3 principal sectors: industrial and commercial loans, loans to individuals, and all other loans.[5] Of the exogenous variables A/B in equation (2a/2b), Indcom reflects the bank type i.e., in commercial banks most loans are large and extended to the business sector while saving/mortgage banks are characterized by many small loans/mortgages to households[6]. Table 1 depicts some characteristics of the two types of banks: commercial vs. saving/mortgage during the sample period.

[5] By the new Basle Accord (2002), non credit risk should also affect risk adjusted capital. However, within the sample period that influence was neglected.

[6] Note that our database consists all banks rather than a sample therefore, bank asset (Lasset) changes only along the years (time series) but not between banks in a aparticular year (cross section). As the correlation coefficient between GDP and Lasset is 0.97 we exclude Lasset from the regressions below.

Table 1

Main Characteristics of Commercial vs. Saving/Mortgage banks
(q1/1994 - q2/2003, %)

Commercial Banks

(All period)

	Lasset	ROC	CAR	BPROC	PROV	CHARGE_OFI	NONPER	NIM	IOC	RAC	INDCOM
Avg	6.7	14.71	8.39	15.34	0.64	0.60	0.76	4.18	8.00	12.54	14.20
Median	6.7	14.69	8.41	15.37	0.63	0.58	0.69	4.22	8.15	12.47	14.17
Std	0.1	0.45	0.29	0.50	0.14	0.13	0.12	0.10	0.45	0.25	0.28
Min	6.6	13.68	7.78	14.23	0.46	0.41	0.63	4.05	6.32	12.15	13.65
Max	6.9	15.47	9.22	16.10	1.15	1.11	1.01	4.36	8.42	13.01	14.85
Skewness	-0.1	-0.42	0.66	-0.29	2.46	2.77	0.79	-0.04	-2.77	0.33	-0.03
Kurtosis	-1.2	0.15	2.61	-0.21	9.45	11.13	-0.78	-1.55	9.64	-1.06	0.76

(q1/1994 - q2/1999)

	Lasset	ROC	CAR	BPROC	PROV	CHARGE_OFI	NONPER	NIM	IOC	RAC	INDCOM
Avg	6.7	14.55	8.27	15.15	0.60	0.58	0.86	4.26	8.01	12.77	14.32
Median	6.7	14.53	8.20	15.08	0.57	0.56	0.86	4.27	8.20	12.77	14.28
Std	0.1	0.41	0.38	0.50	0.20	0.20	0.09	0.06	0.63	0.15	0.24
Min	6.6	13.68	7.78	14.23	0.46	0.41	0.73	4.13	6.32	12.53	13.98
Max	6.8	15.10	9.22	16.05	1.15	1.11	1.01	4.36	8.42	13.01	14.85
Skewness	0.8	-0.82	1.88	0.08	2.64	2.64	0.07	-0.88	-2.57	0.07	1.06
Kurtosis	1.1	1.37	5.19	0.80	7.68	7.79	-1.05	2.11	6.99	-0.79	1.70

(q3/1999 - q2/2003)

	Lasset	ROC	CAR	BPROC	PROV	CHARGE_OFI	NONPER	NIM	IOC	RAC	INDCOM
Avg	6.81	14.86	8.50	15.52	0.66	0.62	0.66	4.11	7.99	12.34	14.09
Median	6.81	14.89	8.51	15.55	0.66	0.62	0.66	4.07	8.12	12.36	14.16
Std	0.04	0.46	0.12	0.44	0.03	0.03	0.02	0.07	0.22	0.10	0.27
Min	6.74	13.92	8.33	14.62	0.63	0.58	0.63	4.05	7.67	12.15	13.65
Max	6.87	15.47	8.68	16.10	0.70	0.67	0.69	4.23	8.19	12.47	14.48
Skewness	0.025	-0.66	0.17	-0.61	0.26	0.26	0.00	1.09	-0.63	-0.64	-0.43
Kurtosis	-0.574	0.36	-0.77	0.38	-1.41	-0.04	-0.59	-0.77	-1.81	-0.22	-0.94

Saving/Mortgage Banks

(All period)

	Lasset	ROC	CAR	BPROC	PROV	CHRG_OFI	NONPER	NIM	IOC	RAC	INDCOM
Avg	6.03	10.87	8.53	11.18	0.30	0.27	0.96	3.18	7.49	15.20	47.20
Median	6.01	11.36	8.45	11.62	0.32	0.28	1.02	3.18	7.67	15.18	47.17
Std	0.03	1.54	0.32	1.51	0.06	0.08	0.25	0.09	0.49	0.33	1.27
Min	6.00	7.84	7.93	8.18	0.21	0.16	0.58	3.07	5.55	14.48	45.11
Max	6.16	13.91	9.39	14.23	0.41	0.51	1.38	3.34	7.80	15.68	49.15
Skewness	2.92	-0.52	0.83	-0.48	-0.18	0.90	-0.11	0.48	-3.30	-0.34	0.09
Kurtosis	10.05	-0.13	1.44	-0.05	-1.09	1.95	-1.39	-0.92	12.59	-0.35	-1.31

(q1/1994 - q2/1999)

	Lasset	ROC	CAR	BPROC	PROV	CHRG_OFI	NONPER	NIM	IOC	RAC	INDCOM
Avg	6.02	10.21	8.39	10.55	0.34	0.34	1.14	3.21	7.43	15.38	46.56
Median	6.01	9.61	8.35	9.93	0.33	0.32	1.18	3.21	7.72	15.50	46.21
Std	0.05	2.01	0.38	2.00	0.03	0.06	0.20	0.10	0.69	0.31	1.14
Min	6.00	7.84	7.93	8.18	0.31	0.27	0.64	3.07	5.55	14.74	45.11
Max	6.16	13.91	9.39	14.23	0.41	0.51	1.38	3.34	7.80	15.68	48.59
Skewness	3.14	0.60	2.23	0.61	1.28	2.55	-2.04	-0.02	-2.71	-0.98	0.65
Kurtosis	9.88	-0.77	6.56	-0.76	0.97	7.48	5.66	-1.39	7.52	0.27	-0.77

(q3/1999 - q2/2003)

	Lasset	ROC	CAR	BPROC	PROV	CHRG_OFI	NONPER	NIM	IOC	RAC	INDCOM
Avg	6.03	11.48	8.65	11.75	0.27	0.21	0.79	3.15	7.54	15.04	47.79
Median	6.02	11.55	8.63	11.80	0.25	0.21	0.75	3.13	7.62	15.13	48.01
Std	0.02	0.49	0.21	0.45	0.06	0.05	0.16	0.07	0.22	0.27	1.12
Min	6.01	10.56	8.27	10.92	0.21	0.16	0.58	3.08	7.24	14.48	46.07
Max	6.06	12.29	8.99	12.55	0.36	0.29	1.02	3.26	7.80	15.37	49.15
Skewness	0.38	-0.39	0.00	-0.16	0.83	0.60	0.30	0.56	-0.39	-0.90	-0.22
Kurtosis	-1.68	0.18	0.08	0.39	-0.97	-0.80	-1.44	-1.38	-1.77	0.50	-1.55

Description of Variables

Lasset - Log of total asset
ROC - Net income to equity
CAR - Equity to total asset
BPROC - Return (Before Provisions) On Capital = (Net income + Loan-Loss Provision)/Equity Capital
PROV - Loan-Loss Provisions to Gross Loans
CHARGE-OFF - Net charge off to gross loans
NONPER - Non Performing Assets to Assets
NIM - Net Interest Margin
IOC - Yield On Earning Assets
RAC - Total capital to risk-weighted assets
INDCOM - 1-4 Family Mortgages/Gross Assets

It is clearly shown that saving/mortgage banks are less profitable, exposed to smaller credit risks, and set aside more capital compared to commercial banks. For example, BPROC of commercial banks is as much as 150% that of saving/mortgage banks while NIM of the former is one percent higher than that of the latter. Other profitability measures such as ROC and IOC in commercial banks are also higher than their respective in saving/mortgage banks. In addition, credit risks such as loan-loss provision and net charge-offs of commercial banks are larger than those in saving/mortgage banks. Contrarily, the equity is quite similar between these two types of banks; a phenomenon that explains the higher Risk-Adjusted Capital (RAC) of saving/mortgage banks. Both sectors increased their capital level and profitability measures i.e., CAR and BPROC in the second sub period. However, while commercial banks evident larger credit risks, saving/mortgage banks' risks decreased during the second sub period. The structural differences between commercial and saving/mortgage banks are partially explained by the credit portfolio characteristic. Particularly, the weight of mortgages extended to households to gross assets is substantially higher in saving/mortgage banks. This phenomenon is consistent with RAC of the above model.

In order to test the similarity between commercial and saving/mortgage banks regarding profitability, capital, and risk we run equality tests concerning Average (ANOVA), Median (Kruskal-Wallis test and Van der Waerden test), and Variance (F-test and Levene test). It is found that CAR differences are not significant while BPROC, NIM, ROC, IOC, and most risk indices are higher in commercial banks rather than saving/mortgage banks at the 95% significance level. Notice that these findings are consistent with the model's inferences regarding risk adjusted capital and profitability.

We test the hypotheses in (2a) and (2b) regarding commercial and saving/mortgage banks by running Three-Stage LS regressions, as follows:

Table 2

Three Stage LS Regression Results*

Commercial Banks: All Period

Endogenous Variable:	CAR	
	Coefficient	t Statistic
Constant	9.638	*2.295*
BPROC	0.161	*2.567*
CHARGE-OFF-1	-0.029	-0.103
GDP	-0.035	-0.714
Tbill	-0.075	-0.981
@TREND	0.048	0.919
Adj. R-Square	0.608	
D.W.	1.050	

Endogenous Variable:	BPROC	
	Coefficient	t Statistic
Constant	-19.088	-1.683
CAR	1.094	*2.567*
CHARGE-OFF-1	0.297	0.397
GDP	0.271	*2.286*
Tbill	-0.249	-1.258
@TREND	-0.293	*-2.317*
Adj. R-Square	0.064	
D.W.	1.407	

Saving/Mortgage Banks: All Period

Endogenous Variable:	CAR	
	Coefficient	t Statistic
Constant	8.410	1.486
BPROC	0.197	*5.480*
CHARGE-OFF-1	0.596	0.571
GDP	-0.016	-0.260
Tbill	-0.123	-1.664
@TREND	0.005	0.078
Adj. R-Square	0.630	
D.W.	1.182	

Endogenous Variable:	BPROC	
	Coefficient	t Statistic
Constant	-50.313	*-2.485*
CAR	2.926	*5.480*
CHARGE-OFF-1	4.114	1.038
GDP	0.348	1.578
Tbill	0.106	0.350
@TREND	-0.259	-1.188
Adj. R-Square	0.626	
D.W.	0.941	

PANEL Regression: Fixed Effect

Commercial Banks

Endogenous Variable:	CAR	
	Coefficient	t Statistic
Constant	6.401	1.773
BPROC	-0.103	*-2.351*
CHARGE-OFF-1	0.126	0.768
Adj. R-Square	0.87	
D.W.	2.02	

Endogenous Variable:	BPROC	
	Coefficient	t Statistic
Constant	16.627	*3.484*
CAR	-0.602	-1.564
CHARGE-OFF-1	0.333	0.505
Adj. R-Square	0.14	
D.W.	1.57	

Saving/Mortgage Banks

Endogenous Variable:	CAR	
	Coefficient	t Statistic
Constant	*4.181*	1.097
BPROC	0.025	0.799
CHARGE-OFF-1	1.883	*2.683*
Adj. R-Square	0.61	
D.W.	0.65	

Endogenous Variable:	BPROC	
	Coefficient	t Statistic
Constant	-6.263	-1.227
CAR	1.867	*4.793*
CHARGE-OFF-1	-6.886	*-2.648*
Adj. R-Square	0.55	
D.W.	1.68	

	Coefficient	t Statistic
GDP	0.042	1.011
Tbill	-0.163	*-2.669*
@TREND	-0.025	-0.563

* Italic red figure represents confidence level at 95%.

The upper part of Table 2 depicts the results of the equation system regarding commercial and saving/mortgage banks for the entire period. It is found that CAR and BPROC positively affect each other in both sectors, contrarily with prior expectations. In 3 out of 4 equations RISK positively affected the endogenous variables except for CAR of commercial banks. This result is consistent with expectations however the significance of the results is quite low. The exogenous variable, GDP, positively affects BPROC but negatively affected CAR. The riskless interest rate (Tbill) negatively affects CAR, as expected although insignificantly. This can be explained by the relatively high interest rate prevailed during the sample period; a level that raised the opportunity costs of capital holdings.

In the lower part of Table 2 we present the results of the above two system equations running this time together as a panel assuming "fixed effect", as follows:

$$
\begin{aligned}
&\text{c\_car} = \alpha_1 + \beta_1 \cdot \text{c\_bproc} + \chi_1 \cdot \text{c\_chrg\_off}_{-1} + k \cdot \text{gdp} + 1 \cdot \mathit{Tbill} + \text{m} \cdot @\text{trend} \\
&\text{c\_bproc} = \alpha_2 + \beta_2 \cdot \text{c\_car} + \chi_2 \cdot \text{c\_chrg\_off}_{-1} + k \cdot \text{gdp} + 1 \cdot \mathit{Tbill} + \text{m} \cdot @\text{trend} \\
&\text{m\_car} = \alpha_3 + \beta_3 \cdot \text{m\_bproc} + \chi_3 \cdot \text{m\_chrg\_off}_{-1} + k \cdot \text{gdp} + 1 \cdot \mathit{Tbill} + \text{m} \cdot @\text{trend} \\
&\text{m\_bproc} = \alpha_4 + \beta_4 \cdot \text{m\_car} + \chi_4 \cdot \text{m\_chrg\_off}_{-1} + k \cdot \text{gdp} + 1 \cdot \mathit{Tbill} + \text{m} \cdot @\text{trend}
\end{aligned}
\qquad (3)
$$

Where, leading "c_" and "m_" represent commercial and saving/mortgage banks, respectively. The influence of charge-off$_{-1}$ (RISK) on CAR and BPOC in the saving/mortgage sector is consistent with our hypothesis while that influences CAR and BPROC in the commercial banking sector is insignificant. The exogenous variables: GDP and Tbill affect the endogenous variables also as expected. Finally, the constants of the four equations seem quite different (fixed effect coefficients - $\alpha_1..\alpha_4$) justifying the use of the panel in (3).

At this stage one can notice the following two preliminary results (1) the differences between commercial and saving/mortgage banks presented in Table 2 are not substantial and (2) the results are usually not significant and there exists an autocorrelation represented by relatively low D.W. statistics.

Although these findings are consistent with the model inferences, the small values of the D.W. statistics and the correlograms of the residuals - indicating autoregressive relations of order higher than 1, point out on a potential problem of spurious regressions. This phenomenon occurs whenever the variables are non stationary. Thus, the relationships erroneously found in the system are the result of long term increase/decrease in the series instead of real co-movements between the exogenous/endogenous variables. The evolution of the main variables: CAR, BPROC, and RISK are presented in figures 1a and 1b.

It can be seen that CAR in both sectors characterized by positive slope, BPROC characterized by negative slope while both are non stationary. We test these characteristics by running Unit Root Tests, as follows:

According most entries in Table 3 (ADF and PP, with and without trend and intercept) the 3 variables: BPROC, CAR, and RISK are non stationary i.e., we cannot reject the existence of unit root. This contradicts the underlying assumptions and might yield bias coefficients in the regressions results. In order to the cope with this problem one should implement co-integration methodology. Co-integration can also distinct between long run relationships and deviations from that 'equilibrium' in the short run. The positive relation between CAR and BPROC found earlier raises the question whether BPROC is a result of CAR or whether they are determined simultaneously. By the Signals Hypothesis described earlier, CAR should result in BPROC as was found in demirguc-Kunt and Huizinga (1999) while in other models (see for example, Berger 1995) it is determined, simultaneously.

We examine the relation between BPROC, CAR, given RISK and other exogenous variables in commercial vs. savings/mortgage banks by implementing the co-integration methodology of Johansen (1995). The latter is different from other co-integration methodologies such as Engle and Granger (1988) by enabling more than 1 co-integration vectors and assuming dynamic relations among the variables.

Figure 1a

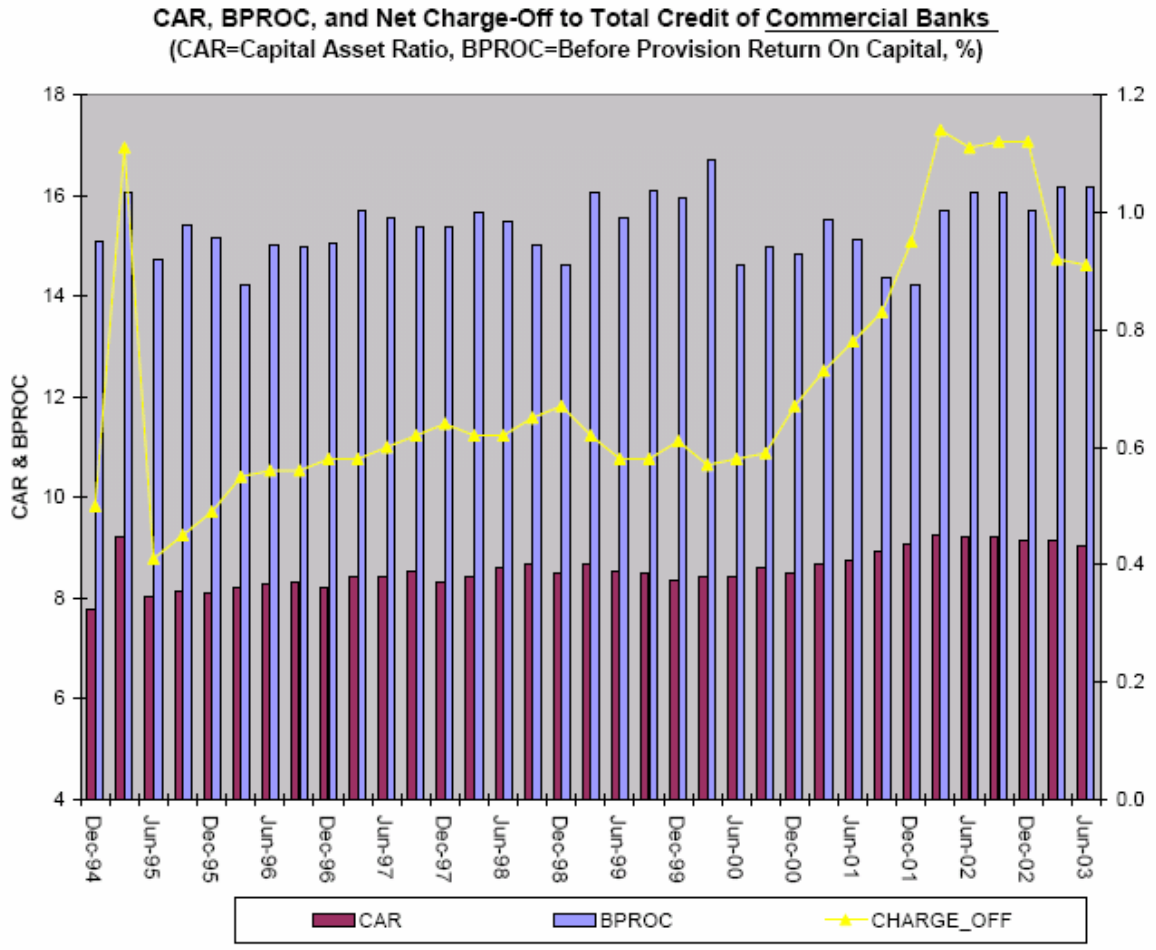

CAR, BPROC, and Net Charge-Off to Total Credit of Commercial Banks
(CAR=Capital Asset Ratio, BPROC=Before Provision Return On Capital, %)
CAR & BPROC
18
16
14
12
10
8
6
4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Dec-94
Jun-95
Dec-95
Jun-96
Dec-96
Jun-97
Dec-97
Jun-98
Dec-98
Jun-99
Dec-99
Jun-00
Dec-00
Jun-01
Dec-01
Jun-02
Dec-02
Jun-03
CAR
BPROC
CHARGE_OFF

Figure 1b

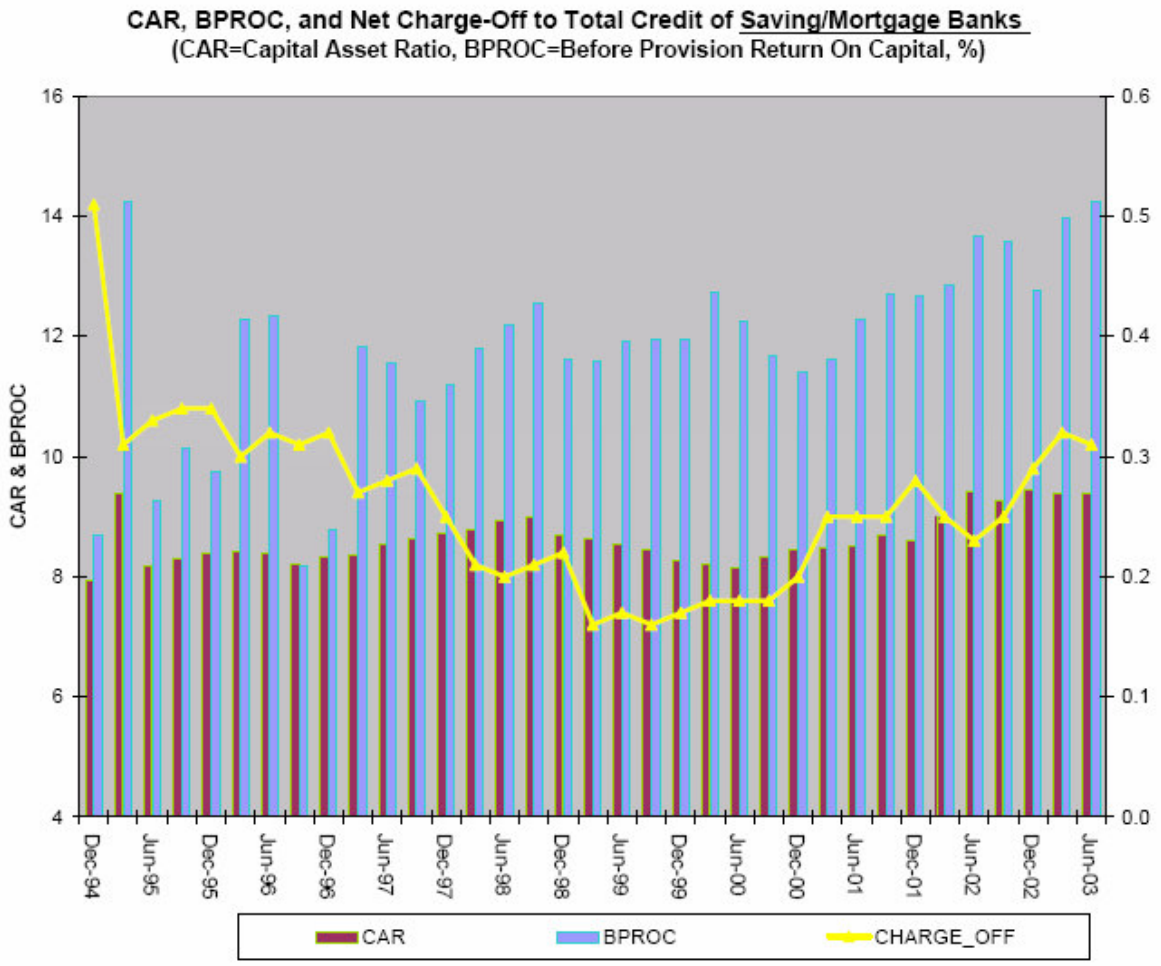

CAR, BPROC, and Net Charge-Off to Total Credit of Saving/Mortgage Banks
(CAR=Capital Asset Ratio, BPROC=Before Provision Return On Capital, %)
CAR & BPROC
16
14
12
10
8
6
4
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Dec-94
Jun-95
Dec-95
Jun-96
Dec-96
Jun-97
Dec-97
Jun-98
Dec-98
Jun-99
Dec-99
Jun-00
Dec-00
Jun-01
Dec-01
Jun-02
Dec-02
Jun-03
CAR
BPROC
CHARGE_OFF

Table 3

Unit Root Tests by ADF[(a)] and PP[(b)]
(q4/1994 - q2/2003)

	Commercial Banks					Saving/Mortgage Banks		
	CAR	PBROC	CHARGE-OFF	Tbill	GDP	CAR	PBROC	CHARGE-OFF
ADF - Levels								
No Intercept and No Trend	1.1	0.1	-0.4	-1.5	3.2	0.5	0.1	-0.4
Intercept and No Trend	-1.0	-2.9	-1.3	-0.7	-1.3	-0.5	-2.1	-1.3
Intercept and Trend	-2.1	-3.2	-4.3	-1.6	-1.0	-1.9	-6.1	-0.5
ADF - 1st Difference								
No Intercept and No Trend	-5.0	-5.3	-5.9	-2.3	-1.2	-4.5	-6.8	-4.9
Intercept and No Trend	-5.2	-5.2	-6.1	-2.5	-2.9	-4.7	-6.9	-4.8
Intercept and Trend	-4.8	-5.1	-5.4	-2.6	-3.2	-4.4	-6.7	-5.6
PP - Levels								
No Intercept and No Trend	1.0	0.4	0.2	-1.2	5.7	1.0	1.0	-1.8
Intercept and No Trend	-3.4	-4.1	-2.5	-0.1	-1.0	-3.0	-4.4	-4.1
Intercept and Trend	-5.5	-4.2	-2.5	-1.4	-1.0	-3.6	-6.6	-3.4
PP - 1st Difference								
No Intercept and No Trend	-13.6	-9.8	-10.3	-3.4	-1.8	-11.1	-13.5	-10.3
Intercept and No Trend	-13.6	-9.6	-10.1	-3.7	-4.3	-11.0	-13.4	-10.0
Intercept and Trend	-14.1	-9.7	-10.4	-3.7	-4.4	-12.0	-13.8	-11.5

Description of Variabes

CAR - Equity to total asset
BPROC - Return (Before Provisions) On Capital = (Net income + Loan-Loss Provision)/Equity Capital
CHARGE-OFF - Net charge off to gross loans
Tbill - Interest Rate of Return on US Tbills
GDP - US Gross Domestic Product

(a) - Augumented Dickey Fuller (ADF) with 1 lag.
(b) - Phillip Pheron (PP) with 3 lags.
Critical Value for both tests at 1% for 1st Difference: No Intercept and No Trend: -2.6; Intercept and No Trend: -3.6; Intercept and Trend: -4.1.

In the first step we find out the best fitting characteristics of the data under various co-integration alternatives. Using Akaike (AIC) and Shwartz (SIC) information criteria we select as the best possibility: rank = 1 and there is intercept and trend in the co-integration equations. Then, we run Johansen's co-integration tests as shown in Table 4.

It can be seen that both λ_{max} and λ_{trace} indicate only 1 co-integration equation at the 1% significance level. The co-integration vector indicating the long run relationships between BPROC and CAR given RISK and another two exogenous variables (GDP and Tbill), is:

(4) $$V: \quad BPROC - \alpha - \beta \cdot CAR = \varepsilon$$

We assume in (4) that BPROC and CAR determind simultaneously, given RISK, GDP, and Tbill. By normalizing the results i.e., dividing all coefficients by the coefficient of BPROC, we obtain the long run vector coefficients for commercial as well as for saving/mortgage banks. Note that the coefficient of commercial banks' CAR negatively affects BPROC and is consistent with what have been expected while that of saving/mortgage banks is positively affects BPROC; both coefficients are significant at 1% level. The constant and the coefficient of @TREND in both banking seectors have the same sign although they have quite different values. Figures 2a and 2b depict the deviation of BPROC from its long run equilibrium calculated by the co-integration vector in equation (4).

From Figure 2 one can see that the deviations are on average closed to 0, symmetrical, and normally distributed (according Jarque-Berra test). For example, the differences between the medians of Long Run BPROC calculated by co-integration equation and the actual ones are 0.5% and 0.2% for commercial (C_BPROC) and saving/mortgage (M_BPROC) banks, respectively. The Figure also distinguishes between 3 sub periods: In the first period ending

Table 4

Johansen's Co-integration Tests

	Commercial Banks		Saving/Mortgage Banks	
	Max Eigenvalue		Max Eigenvalue	
	0.64		0.69	
	ltrace	lmax	ltrace	lmax
	47.2	30.4	46.9	33.8
Critical value at 1% (a)	30.45	23.6	30.45	23.6

Co-integration Equations (Long run relations):

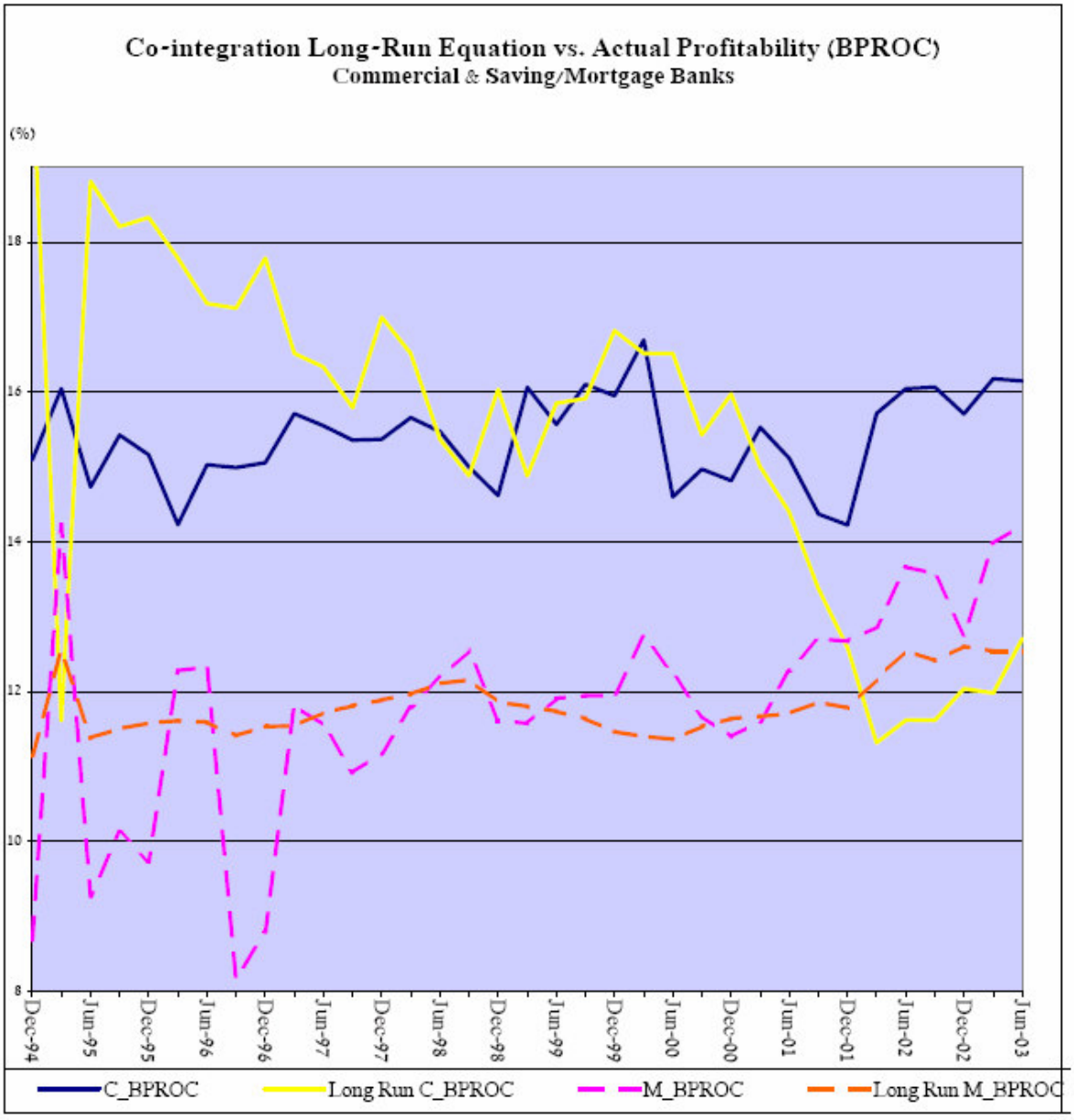
	Coefficient	t-statistic		Coefficient	t-statistic
BPROC-1	1		BPROC-1	1	
CAR-1	5.20	1.47	CAR-1	-0.95	-0.37
@TREND	0.18	0.11	@TREND	0.03	0.14
Constant	-63.27		Constant	-4.03	

Error Correction:(b)

	D(C_BPROC)	D(C_CAR)		D(M_BPROC)	D(M_CAR)
CointEq1: Adjustment Speed	-0.558	-0.160	CointEq1: Adjustment Speed	-1.619	-0.101
	(-3.60842)	(-4.99462)		(-7.61599)	(-1.77870)
D(C_BPROC(-1))	0.072	0.051	D(M_BPROC(-1))	0.599	0.030
	(0.42)	(1.42)		(3.76)	(0.70)
D(C_CAR(-1))	-0.560	-0.089	D(M_CAR(-1))	-1.830	-0.395
	(-1.33002)	(-1.01925)		(-3.17407)	(-2.57060)
C	-16.545	-4.796	C	-18.173	-3.103
	(-3.25520)	(-4.54562)		(-2.88818)	(-1.84966)
C_CHRG_OFF(-1)	4.796	0.149	M_CHRG_OFF(-1)	-0.839	1.197
	(3.16)	(0.47)		(-0.18121)	(0.97)
TBILL	-0.1449	-0.1286	TBILL	-0.1960	0.0110
	(-1.07128)	(-4.58183)		(-1.08598)	-0.2283
GDP	0.1200	0.0455	GDP	0.1668	0.0241
	(3.17)	(5.79)		(4.02)	(2.18)
Adj. R-squared	0.43	0.79	Adj. R-squared	0.71	0.40
F-statistic	5.02	20.90	F-statistic	14.35	4.61
Log likelihood	-22.61	29.27	Log likelihood	-34.09	9.53
Akaike AIC	1.79	-1.35	Akaike AIC	2.49	-0.15
Schwarz SC	2.11	-1.03	Schwarz SC	2.81	0.16
Log Likelihood		7.35	Log Likelihood		-22.69
Akaike Information Criteria		0.59	Akaike Information Criteria		2.41
Schwarz Criteria		1.36	Schwarz Criteria		3.18

(a) Critical values calculated by Johansen and Juelius (1990).
(b) Figures in parentheses represent t-Statistics.

Figure 2


Co-integration Long-Run Equation vs. Actual Profitability (BPROC)
Commercial & Saving/Mortgage Banks
(%)
18
16
14
12
10
8
Dec-94
Jun-95
Dec-95
Jun-96
Dec-96
Jun-97
Dec-97
Jun-98
Dec-98
Jun-99
Dec-99
Jun-00
Dec-00
Jun-01
Dec-01
Jun-02
Dec-02
Jun-03
C_BPROC
Long Run C_BPROC
M_BPROC
Long Run M_BPROC

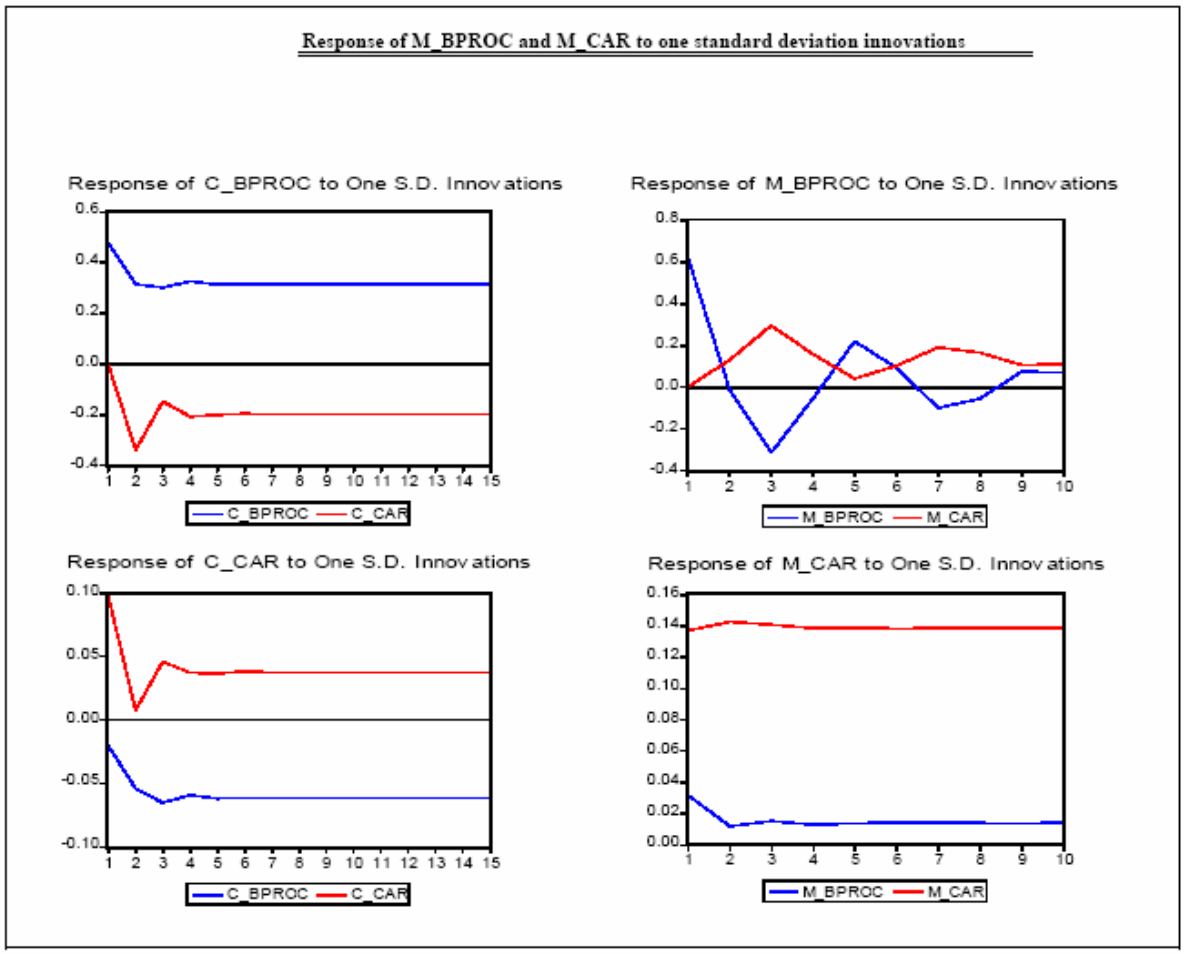
by July 1998 the Long Run BPROC for both banking sectors was higher than the actual BPROC; in the second period ending by March 2001 the series are approximately equal while during the last period Long Run BPROC for both banking sectors was lower than the actual BPROC. This phenomenon probably represents business cycles in the U.S. economy that reflected in BPROC and CAR of both banking sectors during the sample period (See Berger et al., 2000).

By examining the Vector Error Correction (VEC) of the two banking sectors describing the short run fluctuations of the variables in Table 4 we conclude the followings: (1) The adjustment speed of D(C_BPROC) and D(M_BPROC) are -0.52 and -1.2, respectively. This means approximately 2 and 0.8 quarters before returning to equilibrium. This compared with the adjustment speed of D(C_CAR) and D(M_CAR) with -0.16 and -0.10, respectively which means 6 to 10 quarters before returning to equilibrium. The substantial difference between BPROC and CAR for both banking sectors is reflected in Figure 3 presenting the influence of one standard deviation shock/innovation on BPROC and CAR.

From Figure 3 and Table 4 one can seen that innovations in $D(C\_BPROC_{-1})$ and $D(M\_BPROC_{-1})$ positively affect both D(C_BPROC), D(C_CAR) and D(M_BPROC), D(M_CAR), respectively while innovations in $D(C\_CAR_{-1})$ and $D(M\_CAR_{-1})$ negatively affect both D(C_BPROC), D(C_CAR) and D(M_BPROC), D(M_CAR), respectively. Moreover, it can be seen from Figure 3 that in most cases innovations cause non-temporarily influence on the endogenous variables. Yet, the only difference between commercial and saving/mortgage banking sector is the amplitude of variables' deviation as a result of the innovation and the higher significance level of the saving/mortgage banking sectors explanatory variables compared to that of commercial banks.

The most important result in Table 4 is the influence of RISK on BPROC and CAR since that might support or reject our hypothesis. By equation (2a/2b) our hypothesis is that RISK positively affects BPROC of commercial banking sector while positively affects CAR of

Figure 3


Response of M_BPROC and M_CAR to one standard deviation innovations
Response of C_BPROC to One S.D. Innovations
C_BPROC C_CAR
Response of M_BPROC to One S.D. Innovations
M_BPROC M_CAR
Response of C_CAR to One S.D. Innovations
C_BPROC C_CAR
Response of M_CAR to One S.D. Innovations
M_BPROC M_CAR

saving/mortgage banking sector. Although the similarity among the coefficients between these two banking sectors concerning RISK, the results are completely different. $C\_CHRG\_OFF_{-1}$ positively affects D(C_BPROC) and $M\_CHRG\_OFF_{-1}$ positively affects D(M_CAR) as expected, although the latter is insignificant. Moreover, the influence of $C\_CHRG\_OFF_{-1}$ on D(C_CAR) and of $M\_CHRG\_OFF_{-1}$ on D(M_BPROC) found to be negative. This evidence is consistent with our hypothesis: commercial banks price credit risks but, on average, do not set capital aside against them while saving/mortgage banks set capital aside but usually do not price credit risks. Concerning Tbill and GDP, they are both influence the endogenous variables as expected: usually, Tbill negatively affects D(C_CAR), D(M_CAR), D(C_BPROC), and D(M_BPROC) while GDP positively affects these variables. By using co-integration methodology we can conclude that the results are consistent with our hypothesis: commercial banks that characterized by low pricing costs per dollar of credit and the pricing process should add information on the borrowers, price their credit risks. Contrarily, saving/mortgage banks tend to increase their equity as a cushion against credit risks. This is explained by the highly pricing costs per dollar of credit where the information on the borrowers is already known in the market and the probability of default is relatively stable.

5. CONCLUSIONS

In this study we examined the relations between capital, profitability, and risk of U.S. commercial vs. saving/mortgage banking sectors for the period q4/1994 – q2/2003.

Based on a simple model, we explain the differences between these two sectors by discriminating between two types of projects:

(1) Common projects such as mortgages characterized by highly pricing costs per dollar of credit and known/stable probability of default, and

(2) Unique projects such as large scale loans characterized by small pricing costs per dollar of credit and unknown/unstable probability of default.

Based on the model, we test the hypothesis that common projects yield the bank to set aside more capital instead of fully price the loan compared to unique and large projects. Controlling for risk and other explaining variables, this inference is the result of different credit pricing costs. Testing our hypothesis on U.S. commercial banking sector vs. saving/mortgage banks reveals that the former is characterized by higher credit risks and profitability compared to the latter. As capital is approximately equal in both sectors, risk adjusted capital is lower and profitability is higher in commercial banks compared to saving/mortgage banks. Using 3SLS regressions and panel data with fixed effect we find unequivocal results concerning the cross influences of CAR on BPROC and vise versa. For example, RISK positively affected CAR and negatively BPROC in the saving/mortgage banking sector but this influence found also in the commercial banking sector although insignificantly. As capital (CAR) and profitability (BPROC) variables found to be non-stationary during the sample period we tested our hypothesis by implementing a co-integration methodology of Johansen (1995). The results found were consistent with the model's conjecture: RISK positively affected CAR and negatively affected BPROC in saving/mortgage banking sector while for commercial banks the opposite prevailed; yet the latter result was slightly insignificant.

Future research with regard to the model and the empirical tests can be extended to the following areas:

(a) Asymmetrical information between the bank and its depositors,

(b) The impact of bank risk on new depositors where old depositors are indifferent to changes in risk,

(c) The bank engages in other activities rather than providing loans. For example, services that yield also fees,

(d) Testing the model's inferences by using particular banks within the context of panel co-integration.

REFERENCES

Acharya, B. (1988). “A Generalized Econometric Model and Test of a Signaling Hypothesis with Two Discreet Signals,” Journal of Finance 43, 413–429.

Barth, J., D. Groper, and J. Jahera (1998), "A Multi-country Analysis of Bank Capital and Earnings", Review of Pacific Basin Financial Markets and Policies 1(2), 123-55.

Berger, A.N. (1995). “The Relationship between Capital and Earnings in Banking,” Journal of Money, Credit, and Banking 27(2), 432–456.

Berger, A.N., Bonime, S.D., Covitz, D.M., and D. Hancock, (2000), "Why are bank profits so persistent? The roles of product market competition, informational opacity, and regional/macroeconomic shocks", Journal of Banking and Finance 24, 1203-1235.

Booth, J.R., and D.T. Officer (1985). “Commercial Bank Stocks, Interest rate, and systematic risk,” Journal of Economics and Business 37(4), 303–310.

Demirguc-Kunt, A. and H., Huizinga (1999), “Determinants of Commercial Bank Interest Margins and Profitability: Some International Evidence”, The World Bank, Economy Review, 13 (2) , 379-408.

Flannery, M.J., and J.C. James (1984). “The Effect of Interest Rate Changes on the Common Stock Returns of Financial Institutions,” Journal of Finance 39(4), 1141–1153.

Haubrich, J.G., and P. Watchel (1994). “Capital Requirements and Shifts in Commercial Bank Portfolios,” Economic Review, Federal Reserve Bank of Cleveland 3, 2–15.

Jacques, K., and P. Nigro (1994). “How Did Banks React to the Risk-Based Capital Standards?” Office of the Comptroller of the Currency 4, 11–16.

Kendall, S.B., and M.E. Levonian (1992). “Alternative Risk-Based Capital Designs and their Implications for Bank Behavior and the Deposit Insurance Fund,” Working Paper, North American Economics and Finance Association meetings.

Johansen, Soren (1995) Likelihood-based Inference in Cointegrated Vector Autoregressive Models, Oxford University Press.

Neuberger, J.A. (1991). “Risk and Return in Banking: Evidence from Bank Stock Returns,” *Economic Review, Federal Reserve Bank of San Francisco*, No. 4, 18–30.

Osteberg, W.P., and J.B. Thomson (1989). “Bank Capital Requirements and the Riskiness of Banks: A Review,” *Federal Reserve Bank of Cleveland*, 10-17.

Saunders, A., E.Strock, and N.G. Travlos (1990). “Ownership Structure, Deregulation, and Bank Risk Taking,” *Journal of Finance 45*, 643–654.

Shrieves, R.E., and D. Dahl (1992), “Relationship between Risk and Capital in Commercial Banks,” *Journal of Banking and Finance 16(2)*, 439–457.

Stiglitz, J.E., and A. Weiss (1981). “Credit Rationing in Markets with Imperfect Information,” *American Economic Review 71(3)*, 393–410.

Stiroh, K.J., (2000), "How did bank holding companies prosper in the 1990s?", *Journal of Banking and Finance* 24, 1703-1745.

Stone, B.K. (1974), “Systematic Interest-Rate Risk in a Two-Index Model of Returns,” *Journal of Financial and Quantitative Analysis 9(5)*, 709–21.