FEDERAL RESERVE BANK *of* ATLANTA

The "Risk-Adjusted" Price-Concentration Relationship in Banking

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Abstract: Price-concentration studies in banking typically find a significant and negative relationship between consumer deposit rates (i.e., prices) and market concentration. This relationship implies that highly concentrated banking markets are "bad" for depositors. It also provides support for the Structure-Conduct-Performance hypothesis and rejects the Efficient-Structure hypothesis. However, these studies have focused almost exclusively on supply-side control variables and have neglected demand-side variables when estimating the reduced form price-concentration relationship. For example, previous studies have not included in their analysis bank-specific risk variables as measures of cross-sectional derived deposit demand. The authors find that when bank-specific risk variables are included in the analysis the magnitude of the relationship between deposit rates and market concentration decreases by over 50 percent. They offer an explanation for these results based on the correlation between a bank's risk profile and the structure of the market in which it operates. These results suggest that it may be necessary to reconsider the well-established assumption that higher market concentration necessarily leads to anticompetitive deposit pricing behavior by commercial banks. This finding has direct implications for the antitrust evaluations of bank merger and acquisition proposals by regulatory agencies. And, in a more general sense, these results suggest that any Structure-Conduct-Performance-based study that does not explicitly consider the possibility of very different risk profiles of the firms analyzed may indeed miss a very important set of explanatory variables. And, thus, the results from those studies may be spurious.

JEL classification: L11, L21, L40, G21, G28

Key words: structure-conduct-performance, efficient-structure, consumer deposit pricing, risk-adjusted, commercial banks

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1. Introduction

Several articles that test the competing Structure-Performance hypotheses using price data have appeared in the literature. For example, Berger and Hannan (1989, 1992), Calem and Carlino (1991), Hannan and Berger (1991), and Jackson (1992a), each test (among other things) the Structure-Conduct-Performance (S-C-P) hypothesis versus the Efficient-Structure (E-S) hypothesis using price data. In each of these articles the pricing data represent consumer deposit rates set by commercial banks. In general, the results reported in these studies supported a negative and significant relationship between market concentration and deposit rates, providing support for the S-C-P and against the E-S hypothesis. The S-C-P, originated by Mason (1939) and Bain (1951), suggests that more concentrated markets may lead to collusive behavior and monopolistic pricing by firms. The E-S hypothesis, developed by Demsetz (1973) and Peltzman (1977), suggests that profits in concentrated markets may be systematically higher because of market competition over time which dictates that more efficient firms gain larger market share.

There are several documented reasons for using price data in general (Weiss 1986) and banking price data in particular (Hannan and Berger 1991) rather than profit data to test the validity of the S-C-P and E-S hypotheses. The main reason usually offered is that price data provides a less noisy signal, relative to profit data, of cross-sectional differences in the degree of market competition. However, the use of price data from consumer deposits may also have some inherent drawbacks. One possible drawback, discussed by Dick (2005), Berger (1995), and Rhoades and Burke (1990), is the omission of firm-specific variables which may systematically affect the "cost" or the demand for deposits. Several variables may affect a bank's demand for deposits and thus its reservation deposit rate.

For example, one important variable is the cross-sectional riskiness of the individual banks being analyzed. That is, a bank that is more risky is likely to offer higher deposit rates (Brewer and Mondschean, 1994). Therefore, the omission of risk measures may cause a spurious relationship to be estimated between relatively low deposit rates and high market concentration. This is because market concentration may be negatively related to risk (Rhoades and Rutz 1982); and, risk (ceteris paribus) may be positively related to consumer deposit rates. Additionally, this risk-deposit rate relationship may have been accentuated by the moral hazard problems of flat-rate deposit insurance as discussed in Barth and Bradley (1989), Buser, Chen, and Kane (1981), and McKenzie, Cole, and Brown (1992). The critical linkages, however, are between risk and market structure. Are banks in relatively more concentrated markets less risky? If the answer to this question is yes, then the empirical finding of a negative relationship between deposit rates and market concentration no longer provides support for the S-C-P hypothesis, nor does it suggest rejection of the E-S hypothesis. This is because banks in more concentrated markets, if they are indeed less risky, would tend to pay on average lower consumer deposit rates (even in competitive markets) as the marginal value product of consumer deposits is equated to their marginal cost, or wage (deposit) rate.

Does lower risk account for the negative relationship between price and market concentration in the banking industry? This paper uses generalized method of moments (GMM) estimation to empirically test this hypothesis. This empirical test is motivated by: (1) the findings of a significant negative relationship between market concentration and measures of bank riskiness as reported in Rhoades and Rutz (1982), (2) the findings of a positive and significant relationship between uninsured bank deposits and bank riskiness as reported in Brewer and Mondschean (1994), and (3) the possibility of a spurious correlation between deposit rates and market concentration as discussed in Berger (1995).

This study is the first to directly incorporate firm-specific measures of risk into empirical tests of the price-concentration relationship. This is important because, in a very general sense, any Structure-Conduct-Performance based study that does not explicitly consider the possibility of very different risk profiles of the firms analyzed may indeed miss a very important set of explanatory variables. And, thus, the results from those studies may be spurious.

The remainder of this paper provides some background on the S-C-P and E-S hypotheses in section 2, a brief discussion of the model specifications and data in section 3, the empirical results in section 4, some robustness checks in section 5, and a very brief conclusion in section 6.

2. Market Structure, Market Conduct, and Market Performance[1]

The traditional market structure, conduct, and performance (S-C-P) literature occupies center stage in this summary. However, the resource-based view on sustainable competitive advantage, as exemplified by Peteraf (1993), is also discussed because it captures the essence of the debate concerning the validity of the S-C-P paradigm.

The origins of the theoretical foundations of the S-C-P paradigm are often traced to the work of Mason (1939) and Bain (1951). These early works asserted that fewer firms in a market, reflecting a more concentrated *structure*, generally lead to less competitive *conduct* and less competitive *performance*. Conduct was usually defined in terms of competitive intensity in relation to price and output levels; performance was generally related to profit or price relative to cost ratios. Even in those early years, it was recognized that market structure was important only as a predictor of market conduct. Conduct was the variable from which to draw inferences about market performance. However, because conduct was unobservable, market structure was cast in the role of an instrumental (or proxy) variable.

Many economists were uncomfortable with the informality of the S-C-P theory. Beginning in the mid-1960s a more rigorous theoretical foundation for the S-C-P was pursued. Research by Stigler (1964) and several others demonstrated that under certain *specialized* market conditions, the S-C-P would hold. However, other economic theory has challenged the realism of those specialized conditions. Furthermore, this theory has shown that the linkages between market structure variables and market performance can disappear under alternative very specialized conditions as in Baumol, Panzar, and Willig (1982) or under less specialized (but also less rigorous) conditions, as in Bain (1956).[2] Because of this, researchers have turned to empirical studies to address the question of the effect of market structure on conduct and performance.

2.1. Market S-C-P Empirical Studies

Empirical S-C-P studies tend to fall into one of two groups. The first group measures statistical correlations between market concentration and measures of performance (e.g., concentration and profits). The other uses newer methods that attempt to measure and estimate patterns of firm conduct directly, instead of using market structure variables as proxies. This second group offers the more promising approach and in this paper we follow the direct estimation of market conduct approach. While the first group of studies represent a large and increasing literature, Gilbert (1984) concluded that they present a mixed set of results overall and tend to suffer from several major methodological flaws.

One major shortcoming of these empirical S-C-P studies is that they cannot distinguish between efficiency and market power as a source of market concentration or profitability (Demsetz 1973 and Peltzman 1977, 2000). Economic theory tells us that a firm that can operate at lower cost or deliver a superior product will drive its rivals out of business unless the rivals can imitate the successful firm. However, such superiority (or competitive advantage) would be manifested in terms of high market share (concentration) and high relative profitability precisely in those markets that are competitive. More recent studies by Smirlock (1985), Berger (1995), and others have attempted to correct this flaw. Their results suggest that market structure plays an economically insignificant role in explaining market performance. [For an excellent update and review of this empirical S-C-P literature see Shaffer (2004).]

Another major problem with most empirical studies of market structure is the difficulty in defining the true geographic and product market to be evaluated. As discussed in Jackson (1992b) and Shaffer (1992), this problem is especially severe in a multi-product industry such as banking. The problem is further confounded because banks operate in several geographic markets simultaneously, which casts another shadow on the relevance of market structure as a useful predictor of competitive intensity or market conduct The search for a better predictor has led some scholars to advocate the firm-specific, or the resource-based, approach for developing measures of competitive intensity, or market conduct.

2.2. The Resource-Based View

Recently, a model of how firms compete has emerged from the strategic management area. The model starts with the familiar foundation (in strategic management) that firms are heterogeneous. However, as Peteraf (1993, p. 179) states, *"the model has deepened our understanding regarding such topics as how resources are applied and combined, what makes competitive advantage sustainable, the nature of rents, and the origins or heterogeneity."* Peteraf also mentions that the contributions of resource-based work have not been limited to these topics. For example, our understanding of how service firms choose to compete and decide the level of the intensity of that competition is also enriched by the resource-based view in general and Peteraf's model in particular.

It should be noted that these models are related to (and informed by) the very large body of work in the economics literature commonly labeled, or categorized as, product differentiation.[2] The roots of this product differentiation literature can be traced to the seminal work of Chamberlin (1933). A common theme running through the resource-based literature and Peteraf's model is the importance of preserving the conditions that allow the firm to maintain a competitive advantage. Thus, resources that make a firm different (or heterogeneous) relative to its competitors preserve its superior position. This focus on what is often called imperfect imitability and imperfect substitutability provides an impressive foundation for developing models (e.g., Roth and Jackson 1995) that continues to increase our understanding of how firms compete.

The resource-based view contributes to the debate on market structure, conduct, and performance linkages by suggesting that any source of superior performance is less likely to be market-specific (i.e., market structure) and more likely to be firm-specific. Thus, the strategic management as well as the economics literature provides support for the use of firm-specific measures (of risk) in addition to traditional market structure variables.

2.3. Price-Concentration Studies

Berger and Hannan (1989) provide the first comprehensive empirical study of the relationship between consumer deposit rates and market concentration. Using a reduced form price equation, they estimate the relationship between consumer deposit rates and market concentration while controlling for a wide array of market-specific and bank-specific variables. Six different consumer deposit rates at 470 banks over a ten quarter period are used in the analysis. Using a variety of modeling assumptions, Berger and Hannan (1989) conclude that in general (except for longer-term CDs) consumer deposit rates tend to be negatively (and significantly) related to market concentration.

Following Berger and Hannan (1989), Calem and Carlino (1991) investigate the relationship between consumer deposit rates and market structure by explicitly incorporating conduct as the link between structure and performance. They address the question of whether banks typically behave strategically or competitively in general, and whether these behavior patterns are influenced by market concentration in particular. They find that market concentration has a statistically significant but economically small effect on short-term consumer deposits, and that banks tend, in general, to behave more strategically than competitively.

The use of linear models to estimate the price-concentration relationship for consumer deposits is challenged by Jackson (1992a). Using the model from Berger and Hannan (1989), Jackson (1992a) re-estimates it separately for high-, medium-, and low-concentration subsamples. This re-estimation demonstrates that the price-concentration relationship is only negative and significant for the low subsample category for most types of consumer deposits. However, Jackson (1992a) uses a different sample than Berger and Hannan (1989). Berger and Hannan (1992) re-estimated their analysis using the Jackson (1992a) methodology. They concluded that, although their results are not as strong as previously, the relationship between bank deposit rates and market concentration is generally negative, significant, and linear.

2.4. Risk-Price/Risk-Concentration Studies

Risk may influence the estimation of the price-concentration relationship in banking if price is influenced by risk; and risk is influenced by market structure. Previous studies by Rhoades and Rutz (1982) and Heggestad (1977) demonstrated that market structure (concentration) is significantly negatively correlated with measures of bank riskiness. Brewer and Mondschean (1994), Ellis and Flannery (1992), and Hannan and Hanweck (1988) find evidence that the premiums paid on uninsured deposits are positive and significantly related to measures of riskiness. Additionally, Hughes and Mester (1994) find evidence that bank managers exhibit behavior inconsistent with risk-neutrality.

These studies suggest that banks in more concentrated markets prefer and exhibit less risk. As a consequence, they also may pay a lower risk premium on both insured and uninsured deposits. That is, a bank may be willing to pay a relatively higher rate on its insured deposits if it must pay a relatively higher rate on its uninsured deposits (Brewer and Mondschean 1994; and Hannan and Hanweck 1988). This is because insured and uninsured deposits are fungible in terms of satisfying the bank's funding requirements. Thus, uninsured as well as insured deposit rates may be positively related to the level of bank-specific risk. For example, Barth (1991) documents that risky financial institutions, especially those that face financial distress, tend to pay relatively more for insured as well as uninsured deposits. Thus, this study directly incorporates bank-specific measures of risk when estimating the price-concentration relationship.

3. Model Specification and Data

The model developed here has a similar conceptual framework as that discussed in Neumark and Sharpe (1992). It is based on models of the banking firm found in Diamond (1984), Flannery (1982), and

Hughes and Mester (1994), which focus on the bank's role as investment agent for households. That is, banks take savings in the form of deposits from households and transform these funds into loans or securities by lending them out as investments. Banks use the deposits (savings) as inputs to produce loans or securities (investments). Thus, banks are assumed to be more efficient investors relative to depositors because of diversification benefits, a reduction in monitoring costs, or other economies of scale.

The model assumes that the loan and security markets in which banks invest are competitive. This seems reasonable given the large federal funds and Treasury security markets that allow banks to invest on a national scale. However, because banks tend to draw their deposits from confined geographical areas, such as metropolitan statistical areas or counties, the deposit markets are assumed to exhibit departures from perfect competition.

As in Neumark and Sharpe (1992), departures from the perfect competition framework provide part of the basis for the empirical model developed here. For example, if banks in more concentrated deposit markets face a relatively less elastic deposit supply schedule they may extract more of the producers' surplus from the business of investing by paying lower rates on their deposits. Berger and Hannan (1989) provide some evidence of this negative cross-sectional relationship between market concentration and deposit interest rates. However, Jackson (1992a) provides evidence that this cross-sectional relationship between deposit rate levels and market concentration may be ambiguous.

Additionally, our model recognizes that bank managers may not be risk neutral and may choose differing levels of risk in their investment portfolio depending on their risk objectives (Hughes and Mester 1994). Furthermore, risk levels may be negatively related to market concentration as demonstrated in Rhoades and Rutz (1982). Risk levels may also be positively related to market-clearing deposit rates as reported in Brewer and Monschean (1994).

Following Berger and Hannan (1989,1992,and 1993), Calem and Carlino (1991), and Jackson (1989,1992a), our model of bank consumer deposit rate setting behavior is estimated as the following reduced-form price equation:

$$r_{ijt} \quad = \mathbf{a} + \mathbf{ß}CONC_{jt} + \mathbf{?}' X_{ijt} + e_{ijt} , \qquad (1)$$

where; r_{ijt} represents the interest rate paid by bank *i* in local market *j* at time *t* for a specific category of consumer deposits. $CONC_{jt}$ represents a measure of market concentration in local banking market *j* at time *t*, and X_{ijt} represents a vector of control variables. The vector of control variables allow for firm-specific and market-specific variations in deposit demand and supply schedules faced by individual banks. The parameters are denoted by a, ß, and the vector ?', and e_{ijt} represents an error term.

As in most of the cited articles, the three-firm concentration ratio (CR3) is used to measure CONC. [3] Following Jackson (1992a), the other non-risk related explanatory variables included are market growth (MG), market share (MS), the six-month Treasury bill rate (TB6), the natural log of total assets (LOGTA), and a time-period dummy variable (Q_t) for each quarter (*t*) except the first. We also include an indicator variable (BHC) that is equal to one, zero otherwise, if the bank is part of a bank holding company. Being part of a larger organization (BHC) may influence the pricing behavior of the individual bank.

3.1 Risk Variables

We add to this standard set of control variables three other factors to capture information on the major types of risks faced by financial institutions. First, as in Rhoades and Rutz (1982), Brewer and Mondschean (1994), and Hughes and Mester (1994), we use total capital as a percentage of total assets (CRATIO) as a measure of capital adequacy. Of course, the major component of the total capital measure is equity capital. By increasing capital while holding total assets constant, a bank can lower its riskiness. In contrast, insufficient capital relative to total assets makes a bank more risky. During the thrift crisis of the 1980s many poorly capitalized savings and loan associations paid higher rates on insured deposits to attract additional deposits quickly while investing the proceeds in risky projects. Similarly, a low-capital bank may pay higher deposit rates on insured deposits relative to a high-capital bank. The importance of bank capital and capital ratios is well established in the literature. For example, Berger, Herring, and Szego (1995) report that the empirical evidence generally suggests that higher equity is associated with lower overall risk. And, that virtually every bank failure model finds that a higher equity-to-assets ratio is associated with a lower predicted probability of failure.

Second, we use the percentage of non-performing loans to total assets (NONPERF) as a measure of asset quality. A lower NONPERF ratio may be indicative of a stronger economic environment and/or more efficient management of credit risk. It is hypothesized that a lower NONPERF ratio will be associated with less risk, and as a result, a lower deposit rate.

Lastly, we use the quarterly change in the cumulative twelve-month gap between rate-sensitive assets and liabilities as a percentage of total assets (GAPCHG) as a measure of the likely interest rate risk adjustment strategy that the bank is pursuing. This dollar maturity gap variable allows us to test whether banks strategically price consumer deposits as a function of their interest rate risk exposure goals. We assume that banks establish long term interest rate risk exposure targets, and changes in the cumulative twelve-month gap captures exogenous shocks or deviations from that long term target. These deviations from target are assumed to influence the pricing of deposits as banks set deposit prices to correspond to their new demand for rate sensitive assets or liabilities given their long term interest rate risk exposure target.

3.2 The Data

The risk measures and LOGTA above are taken from *Reports of Condition on U.S. domestically-chartered commercial banks.* The other variables, except TB6, are from the *Summary of deposits reports.* The consumer deposit data are taken from the Federal Reserve's *Monthly survey of selected deposits and other accounts.*

On average, our sample consists of about 257 banks observed quarterly over the March 1984 to December 1992 time period. The sample period ends in 1992 as that is the last year interest rate data was collected for the complete set of deposit types used in our study. Our resulting data set is a pooled cross-section time-series sample with 9240 observations for the equally weighted index of consumer deposit rates and the other firm-specific variables.

The definitions of the variables used in this analysis are presented in Table 1. As in the extant literature, the dependent variable is based on consumer (or retail) deposit interest rates paid by banks expressed in basis points. However, we depart somewhat from previous price-concentration studies by using an equally weighted index of three deposit types.[4] These deposit types are money market deposit accounts, Super NOW accounts, and six-month certificates of deposit accounts. These deposit categories have all been used elsewhere individually, as in Berger and Hannan (1989, 1992, 1993), Calem and Carlino

(1991), and Jackson (1989, 1992a, 1992b). Using an index of consumer deposit rates acknowledges that banks may set deposit rates strategically, as discussed in Calem and Carlino 1991. This recognizes that different types of deposits may compete with each other on an intrabank level.[5] Also, the analysis of indexed deposits is consistent with the legal definition of "bank product" which refers to a broad category of banking products and services (Rhoades and Burke 1990).

4. Empirical Model and Results

Based upon the reduced-form price equation developed in Section 3, the following two equations are estimated:

$$r_{ijt} = \mathbf{a} + \mathbf{ß}\, CR3_j + \mathbf{?_1}\, MG_j + \mathbf{?_2}\, MS_i + \mathbf{?_3}\, TB6_t + \mathbf{?_4}\, LOGTA_{it} + \mathbf{?_5}\, BHC_{it} + \mathbf{DUM} + e_{ijt} \qquad (2)$$

and,

$$r_{ijt} = \mathbf{a} + \mathbf{ß}\, CR3_j + \mathbf{?_1}\, MG_j + \mathbf{?_2}\, MS_i + \mathbf{?_3}\, TB6_t + \mathbf{?_4}\, LOGTA_{it} + \mathbf{?_5}\, BHC_{it} + \mathbf{?_6}\, CRATIO_{it} + \mathbf{?_7}\, NONPERF_{it} + \mathbf{?_8}\, GAPCHG_{it} + \mathbf{DUM} + e_{ijt}, \qquad (3)$$

where; r_{ijt} is the equally weighted consumer deposit rate index, e_{ijt} is an error term, **DUM** is equal to a vector of dummy variable and their associated coefficients. The dummy variable (Q_t) equals one when the quarter variable equals t. The other variables are as discussed above and defined in Table 1. Banks tend to adjust deposit rates differently (i.e., more rapidly) in a period of falling interest rates relative to a period of rising interest rates (Berger and Hannan 1991, Jackson 1989, and Neumark and Sharpe 1992). That is why time dummy variables are included in the equation to distinguish rising rate from the falling rate periods.

Summary statistics for the variables used in this study are presented in Table 2, panel A. Panel B of Table 2 presents a correlation matrix of selected variables. There are at least four points worth mentioning about the correlation matrix of Table 2. First, CR3 (the measure of market concentration) is significantly positively correlated with CRATIO and significantly negatively correlated with NONPERF. Both correlations suggest that banks in higher concentration market are less risky. Second, notice that r_{Index} is significantly correlated with the risk variables in a fashion consistent with the hypothesis that lower bank risk is associated with lower deposit rates. Third, the correlation coefficient for TB6 and r_{Index} is very large and significant (0.83). And, fourth, the correlation between r_{Index} and CR3 is negative and significant, although small (-0.08).

These findings from the simple correlation analysis provide motivation to investigate further the role that risk plays in the price-concentration relationship.

4.1 Estimation Technique

Estimation of equations (2) and (3) with pooled cross-sectional time series data and ordinary least squares (OLS) is potentially inefficient because of the likelihood of time-varying, and firm-specific differences in the error terms. Because of these potential problems with serial correlation and heteroskedasticity, the equations are estimated using the Generalized Methods of Moments (GMM) procedure. Moment conditions of the following form are used in the estimation process:

$$g_t\ (q) = \frac{1}{T}\sum_{i=1}^{T} z_t \otimes r_{ijt},$$

where ? = (a, ß, $?_{1,}$ $?_2$, $?_3$, $?_4$, $?_{31}$, $?_{32}$, $?_{33}$, $?_{34}$)′ for equation (2) and ? = (a, ß, $?_{1,}$ $?_2$, $?_3$, $?_4$, $?_5$, $?_6$, $?_7$, $?_{31}$, $?_{32}$, $?_{33}$, $?_{34}$)′ for equation (3). The z_t is the instrumental variables vector. The instruments used in this analysis are the same as the explanatory variables in each equation. Therefore, there is exactly the same number of moment conditions as the parameters to be estimated. The system is fully identified.

$$g_T \ (q)' W_T \ \ g_T \ (q)$$

The GMM estimators are obtained by minimizing the following quadratic form:

with respect to the ? vector. W_T is a symmetric, positive definite weighting matrix. Hansen (1982) has shown that using the inverse of the variance-covariance matrix of the error terms as the weighting matrix gives efficient and consistent estimates of the parameters. Since W_T is not known in advance, the GMM estimators are obtained in a two-stage process. In the first stage, the identity matrix is used as the weighting matrix to obtain initial estimates of the coefficients. Then using these coefficients, consistent estimates of the variance-covariance matrix are obtained. Next, the inverse of this variance-covariance matrix is used as the weighting matrix in the second stage where the coefficients are re-estimated. Notice that in this context, GMM estimators of the coefficients in equations (2) and (3) will be identical to OLS point estimators. However, the standard errors of the estimates are corrected for an unknown form of serial correlation and heteroskedasticity using the Newey-West (1987) correction with one lag. Therefore, the GMM estimators will be consistent and efficient among a large class of linear and nonlinear estimators.

4.2 Model Estimation

The GMM estimation results for equations (2) and (3) are presented in Table 3. The second column of Table 3 shows the results of estimating equation (2).[6] The third column of Table 3 presents the results of estimating equation (3).

Equation (3) is our expanded version of equation (2) that includes the major variable of interest, the risk variables. The GMM estimation of these two equations presented in Table 3 reveals several interesting results.[7] First, notice that in column two the coefficient for concentration (CR3) is relatively large (-0.66), negative and significant at the one percent level. However, in column three when the risk measures are include, the coefficient for concentration (CR3) is reduced by more than fifty percent to -0.30. Although the coefficient is still significant, the magnitude of its influence is reduced by over half. This suggests that concentration is a less significant explanatory variable when risk measures are also included in estimating the price-concentration relationship in banking. Second, note that the coefficients of the risk variables in column three are all significant (at the 5 percent level or better) and have the expected signs. For example, the negative and significant coefficient for CRATIO implies that, on average, banks with lower capital to assets percentages pay more for deposits. Or, conversely, banks with higher capital ratios pay less for deposits. This result is consistent with Rhoades and Rutz (1982) and Brewer and Mondschean (1994). It is also supported by the theoretical model of Hughes and Mester (1994).

The CRATIO variable may however present an estimation problem because of collinearity with LOGTA. That is, larger banks tend to have lower CRATIO, on average. This problem could be eliminated by dropping LOGTA from equation (3). However, LOGTA may be an important variable in explaining risk. LOGTA may be a proxy for portfolio diversification, or *too-big to fail*, or a larger array of services and convenience. Each of these factors may affect the riskiness of the bank and the equilibrium deposit rates it would pay. Thus, we desire to maintain LOGTA in equation (3). Tests of multicollinearity revealed that LOGTA did not present a problem.[8] It is interesting to note, however, that the results of equation (3) are not material affected by deleting LOGTA from the analysis.

The positive and significant coefficient for NONPERF suggests that banks with lower non-performing loans, or less risky portfolios, pay lower deposit rates. This is consistent with banks in high concentration markets paying lower deposits rates given that they also tend to exhibit lower levels of risk in their portfolios.

The coefficient of GAPCHG is positive and significant. This implies that a bank that experiences a larger increase in rate sensitive assets than liabilities last period tends to pay relatively more for short-term (rate sensitive) consumer deposits (liabilities) this period. This may stem from an attempt by the bank to price its deposits in a manner that would maintain its gap at some preset target level. That is, the relative value of short-term deposits is higher because they allow for the adjustment the gap, managing interest rate risk exposure (see Brewer 1985). We find that our main results above are robust to many changes in model specifications. Some of these modeling changes along with several diagnostic checks are discussed in the next section.

5. Robustness checks

The results from estimating equation (3) suggest that our risk variables greatly reduce the importance of market concentration in explaining consumer deposit rates. However, because our risk variables are correlated with market concentration, the issue of multicollinearity between CR3, NONPERF, CRATIO, and GAPCHG must be considered. As with the case of LOGTA and CRATIO mentioned earlier, tests of multicollinearity revealed that no such problem exists for CR3, NONPERF, CRATIO, and GAPCHG.

Additionally, we orthogonalized CR3 with respect to NONPERF, CRATIO, and GAPCHG. Specifically, we regressed separately each of the three risk variables on CR3 and substituted the three sets of residuals from these regressions for the risk variables in equation (3). The procedure provides an estimate of the explanatory power of the risk variables excluding correlations with CR3. This analysis reveals that the residuals of the risk variables have similar coefficients with similar significance levels as the non-orthogonalized risk variables. This is strong evidence that market concentration does not influence the consumer deposit rates through its correlation with the risk characteristics of banks.

Our second modeling consideration for equation (3) acknowledges the possible endogeneity of the market share (MS), market growth (MG), and maturity gap (GAPCHG) variables. We recognize that multiple endogenous variables, or simultaneous equations, could easily be handled within our GMM estimation framework. However, because the notion that consumer deposit rates (the dependent variable in our model) may influence the banks MS (an independent variable in our model) is well known we go a step farther.[9] In particular, we address the endogeneity possibility by estimating equation (3) without the MS variable. That analysis reveals that the omission of MS does not change our results.

The next independent variable of concern is market growth (MG). Again, we address the endogeneity possibility by estimating equation (3) without the MG variable. That analysis reveals that the omission of MG does not change our results.

To argue that GAPCHG is endogenous is to argue that deposit rates not only influence the structure of deposit demand but also the structure of *loan demand*. That is, because the maturity gap is the difference between rate sensitive assets and liabilities, and because deposit rates are unlikely to affect asset (loan) quantities, it is unlikely that deposit rates influence the maturity gap as much as the maturity gap influences deposit rates. Stated differently, bank managers are more likely to have significantly more control over deposit rates than over their maturity gaps. As such, deposit rates are more likely to be changed by bank managers as the maturity gap changes rather than vice versa.

Thus, although it may appear at first glance that CR3, MS, MG, and GAPCHG suffer from endogeneity problems in equation (3), closer inspection reveals that for each of these variable that is not the case.

Our final modeling consideration addresses the use of the deposit rate index. If we use individual deposit rates to estimate equation (3), our results are qualitatively similar. In general, the addition of risk variables to our consumer deposit rates estimation equation either eliminates or significantly reduces the explanatory power of market concentration for each of the four deposit rates when analyzed on an individual basis.

6. Conclusion

The debate on whether market concentration implies collusive or competitive market behavior continues. The use of price instead of profitability as an indicator of performance may well serve as a superior form of analysis in this debate. Such analysis, however, must incorporate an examination of the relevant firm-specific risk variables when estimating these relationships. As with the results reported herein for our index of consumer deposit rates, it is demonstrated that the negative relationship between price and market concentration may say more about the riskiness of banks in concentrated markets rather than it does about collusive behavior. And, although this study focuses on the banking industry, the results may well be indicative of many other industries. More generally, in any industry where firm specific risks are highly correlated with market structures studies that do not explicitly model these firm specific risks will suffer serious specification errors.

Endnotes

1. For an excellent overview of this literature see Shaffer (1994). This section draws heavily from his article.

2. We thank Stephen Rhoades for pointing this out to us.

3. We obtain similar results using the Herfindahl Index in equation (3).

4. We also estimated the equations using all possible combinations of the deposit rates used in the study as alternative indexes. The results were qualitatively similar for equation (3).

5. We test this hypothesis by estimating time-series correlations of the three deposit rates for each bank in our sample that has a complete time-series of rates. We find that all three rates are significantly correlated (at the 5 percent level) over time for over 94 percent of banks tested.

6. We began the empirical analysis by comparing the estimated results from equation (2) to previous studies in the literature. Using MMDA (money market deposit account) rates as the test case we were able to exactly replicate the coefficient of the price-concentration relationship as reported by Berger and Hannan (1989) and Jackson (1992a).

7. We also estimate equations (2) and (3) using OLS for each quarter (i.e., time series). The results are that for 25 of the 36 cross-sectional estimations of equation (2) CR3 has a negative and significant (at the 5 percent level) coefficient. When the risk variables are added [i.e., equation (3)] the coefficient of CR3 becomes insignificant in 32 of the 36 cases above. We thank Robert Connolly for recommending this analysis.

8. We orthogonalized CRATIO and LOGTA by: (1) regressing CRATIO on LOGTA, and (2) substituting the residuals from this regression for CRATIO in equation (3). This provides an estimate of the explanatory power of CRATIO excluding correlations with LOGTA. When this is done LOGTA is insignificant, and residual (CRATIO) is very significant and negative.

9. We thank Timothy Hannan for pointing this out to us.

REFERENCES

Bain, J. S., Relation of Profit Rate to Industry Concentration, *Quarterly Journal of Economics,* 65 (August 1951), 293-324.

Bain, J.S., *Barriers to New Competition*, Harvard University Press, Cambridge, MA, 1956.

Barth, James R., *The Great Savings and Loan Debacle*, The AEI Press, Washington, DC, 1991.

Barth, James R., and Michael G. Bradley. Thrift Deregulation and Federal Deposit Insurance, *Journal of Financial Services Research*, 2 (September 1989), 231-259.

Baumol, W., J. C. Panzar, and R. D. Willig, *Contestable Markets and the Theory of Industry Structure,* Harcourt Brace Jovanovich, San Diego, CA, 1982.

Berger, Allen N., The Profit-Structure Relationship in Banking--Tests of Market-Power and Efficient-Structure Hypotheses, *Journal of Money, Credit, and Banking*, 27 (May 1995), 404-431.

Berger, Allen N., Richard J. Herring, Giorgio P. Szego. (1995) The role of capital in financial institutions. Journal of Banking and Finance 19, 393-430.

Berger, Allen N., and Timothy H. Hannon, "The Price-Concentration Relationship in Banking, *Review of Economics and Statistics*, 71 (May 1989), 291-299.

Berger, Allen N., and Timothy H. Hannon, "The Price-Concentration Relationship in Banking: A Reply, *Review of Economics and Statistics*, 74 (February 1992), 376-379.

Berger, Allen N., and Timothy H. Hannon, "Using Efficiency Measures to Distinguish among Alternative Explanations of the Structure-Performance Relationship in Banking, *Finance and Economics Discussion Series* 93-18, Federal Reserve Board (1993).

Bhattacharya, Sudipto, and Anjan V. Thakor, **?** Contemporary Banking Theory, *Journal of Financial Intermediation*, 3 (October 1993), 2-50.

Brewer, Elijah III, **?** Bank Gap Management and the Use of Financial Futures,**?** *Economic Prospective*, Federal Reserve Bank of Chicago, 9 (March/April 1985), 12-22.

Brewer, Elijah III, and Thomas H. Mondschean, "An Empirical Test of the Incentive Effects of Deposit Insurance: The Case of Junk Bonds at Savings and Loan Associations," *Journal of Money, Credit and Banking, 26 (February 1994), 146-164.*

Buser, S.A., A.H. Chen, and E.J. Kane, "Federal Deposit Insurance, Regulatory Policy, and Optimal

Bank Capital," *Journal of Finance*, 36 (March 1981), 51-60.

Calem, Paul S., and Gerald A. Carlino, "The Concentration/Conduct Relationship in Bank Deposit Markets," *Review of Economics and Statistics*, 73 (May 1991), 268-276.

Chamberlin, Edward H., *The Theory of Monopolistic Competition*, Harvard University Press, Cambridge, MA, 1933.

Daskin, Alan J., and John D. Wolken, "An Empirical Investigation of the Critical Herfindahl Index in Banking," *Journal of Economics and Business*, 41 (May 1989), 95-105.

Demsetz, Harold, "Industry Structure, Market Rivalry, and Public Policy," *Journal of Law and Economics*, 16 (April 1973), 1-9.

Diamond, D.W., "Financial Intermediation and Delegated Monitoring," *Review of Economic Studies*, 51 (1984), 393-414.

Ellis, David M.,and Mark J. Flannery, Does the Debt Market Assess Large Banks Risk? Time Series Evidence from Money Center CDs, *Journal of Monetary Economics*, 30 (December 1992), 481-502.

Flannery, Mark J., "Retail Bank Deposits as Quasi-Fixed Factors of Production." *American Economic Review*, 72 (1982), 527-535.

Gilbert, R. A., "Bank Market Structure and Competition: A Survey," *Journal of Money, Credit, and Banking*, 16 (November 1984), 617-45.

Hannan, Timothy H., and Allen N. Berger. "The Rigidity of Prices: Evidence from the Banking Industry,"*American Economic Review*, 81 (September 1991), 938-945.

Hannan, Timothy H., and Gerald A. Hanweck, Bank Insolvency Risk and the Market for Large Certificates of Deposit, *Journal of Money, Credit, and Banking*, 20 (1988), 203-211.

Hansen, Lars P., Large Sample Properties of Generalized Method of Moments Estimators, *Econometrica*, 50 (July 1982), 1269-1286.

Hansen, Lars P., and Kenneth J. Singleton, “Generalized Instrumental Variables Estimation of Nonlinear Rational Expectations Models,” *Econometrica*, 50 (1982), 1269-1286.

Heggestad, Arnold A., Market Structure, Risk and Profitability in Commercial Banking, *Journal of Finance*, 32 (1977), 1207-1216.

Hughes, Joseph P., and Lorreta J. Mester, ?Bank Managers Objectives, *Working Paper No. 94-8*, Federal Reserve Bank of Philadelphia (April 1994).

Jackson, William E. III, "Market Structure and Price Adjustments: Evidence from the Banking Industry," *Unpublished Ph.D. Dissertation*, University of Chicago, June 1989.

Jackson, William E. III, "The Price-Concentration Relationship in Banking: A Comment," *Review of Economics and Statistics*, 74 (February 1992a), 373-376.

Jackson, William E. III, "Is the Market Well Defined in Bank Merger and Acquisition Analysis?" *Review of Economics and Statistics*, 74 (November 1992b), 655-661.

Mason, E. S., "Price and Production Policies of Large-Scale Enterprise," *American Economic Review*, 29 (1939), 61-74

McKenzie, Joseph A., Rebel A. Cole, and Richard A. Brown, "Moral Hazard, Portfolio Allocation, and Asset Returns for Thrift Institutions." *Journal of Financial Service Research*, 5 (April 1992), 315-339.

Neumark, David, and Steven A. Sharpe, "Market Structure and the Nature of Price Rigidity: Evidence from the Market for Consumer Deposits." *Quarterly Journal of Economics*, 107 (May 1992), 657-80.

Newey, W., and K. West, "A simple Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix," *Econometrica*, 55 (1987), 703-708.

Peltzman, Samuel, "The Gains and Losses from Industrial Concentration," *Journal of Law and Economics*, 20 (October 1977), 229-263.

Peltzman, Samuel, " Prices Rise Faster than They Fall", *Journal of Political Economy,* 108 (June 2000), 466-502.

Peteraf, M. A., "The Cornerstones of Competitive Advantage: A Resource-Based View," *Strategic Management Journal*, 14 (1993), 179-191.

Rhoades, Stephen, "Structure-Performance Studies in Banking: An Updated Summary and Evaluation," *Staff Study No. 119*, Federal Reserve Board (1982).

Rhoades, Stephen A., and Jim Burke, "Economic and Political Foundations of Section 7 Enforcement in the 1980's," *The Antitrust Bulletin*, 35 (Summer 1990), 373-446.

Rhoades, Stephen A., and Roger D. Rutz, "Market Power and Firm Risk: A Test of the 'Quiet Life'

Hypothesis," *Journal of Monetary Economics*, 9 (1982), 73-85.

Roth, Aleda V., and William E. Jackson III, ? Strategic Determinants of Service Quality and Performance: Evidence from the Banking Industry,? *Management Science*, 41 (1995), 1720-1733.

Salinger, Michael, "The Concentration-Margins Relationship Reconsidered," in *Brookings Papers on Economic Activity: Microeconomics,* Martin N. Bailey and Clifford Winston (eds.), Brookings Institution, Washington, DC (1990).

Shaffer, S. "Competitiveness in Banking," in *The New Palgrave Dictionary of Money and Finance,* Macmillan Press, London, 1992, 414-16.

Shaffer, S., "Bank Competition in Concentrated Markets, *Business Review,* Federal Reserve Bank of Philadelphia (March/April 1994), 3-16.

Smirlock, Michael, "Evidence on the (Non)Relationship between Concentration and Profitability in Banking," *Journal of Money,Credit, and Banking*, 17 (February 1985), 69-83.

Stigler, G. J., "A Theory of Oligopoly," *Journal of Political Economy,* 72 (February 1964), 44-61.

Weiss, Leonard, "Concentration and Price -- Not Concentration and Profits," *Manuscript*, University of Wisconsin, 1986.

Table 1. VARIABLE DEFINITIONS

<u>Endogenous Variables (r)</u>

r_{mmda}	-	Money market deposit account rate in basis points paid on the largest dollar volume of deposits issued during the 7-day period ending on the last Wednesday of the month of the respective quarter, 3/84-12/92.
r_{snow}	-	Super-NOW rate for the same period.
r_{cd6}	-	6-month certificates of deposit rate for the same period.
r_{Index}	-	Equally weighted index (average) of the three deposit rate variables above.

<u>Risk Variables</u>

CRATIO	-	Total capital as a percentage of total assets each quarter.
NONPERF	-	Non-performing loans as a percentage of total assets each quarter.
GAPCHG	-	Change in cumulative 12-month gap as a percentage of total assets each quarter.

<u>Other Variables</u>

CR3	-	3-firm deposit concentration percentage for the local banking market as of year-end.
MS	-	Individual banks market share percentage as of year-end.
MG	-	annual market deposit growth percentage.
TB6	-	Secondary market monthly average six-month Treasury bill rate in basis points last month of each quarter.
LOGTA	-	Natural log of total assets each quarter.
BHC	-	Dummy variable equal to one [zero otherwise] if the bank is part of a bank holding compamy
$Q_2 – Q_{36}$	-	Time dummy variables for 35 of the 36 quarters in the study.

Table 2. SUMMARY STATISTICS and CORRELATION ANALYSIS (N = 9240)

Panel A. Summary Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
r_{Index}	631.37	106.25	309.33	1050.00
CRATIO	7.51	2.92	-22.97	51.82
NONPERF	1.53	1.74	0.00	25.99
GAPCHG	0.06	7.36	-71.55	72.85
CR3	58.34	18.61	19.69	100.00
MS	14.80	15.18	0.02	100.00
MG	12.16	139.63	-88.86	746.00
TB6	707.93	191.77	304.00	1124.00
LOGTA	13.11	2.07	8.27	18.96
BHC	0.66	0.48	0.00	1.00

Panel B. Correlation Analysis

	r_{Index}	CRATIO	NONPERF	GAPCHG	CR3	TB6	LOGTA
r_{Index}	**1.00 (0.00)**						
CRATIO	**-0.04 (0.00)**	1.00 (0.00)					
NONPERF	**-0.01 (0.07)**	-0.21 (0.00)	1.00 (0.00)				
GAPCHG	**-0.04 (0.00)**	0.10 (0.00)	-0.01 (0.16)	1.00 (0.00)			
CR3	**-0.08 (0.00)**	**0.11 (0.00)**	**-0.10 (0.00)**	**-0.005 (0.56)**	**1.00 (0.00)**		
TB6	**0.83 (0.00)**	-0.06 (0.00)	-0.05 (0.00)	-0.13 (0.00)	-0.04 (0.00)	1.00 (0.00)	
LOGTA	**-0.05 (0.00)**	-0.49 (0.00)	0.16 (0.00)	0.003 (0.66)	-0.15 (0.01)	-0.05 (0.00)	1.00 (0.00)

Notes: Significance levels are in parentheses beneath the pearson correlation coefficients.

Table 3. GMM Estimation of Risk-Adjusted Relationship Between Equally Weighted Index of Consumer Deposit Rates and Market Structure (N=9240)

Independent Variable	Parameters [Basic Model]	Parameters [Extended Model]
Intercept	366.76 (46.76) ***	380.08 (44.36) ***
CR3	-0.66 (-15.28) ***	-0.30 (-6.97) ***
TB6	0.41 (45.58) ***	0.43 (48.82) ***
BHC	-10.59 (-8.33) ***	-11.44 (-8.89) ***
LOGTA	-2.09 (-6.33) ***	-2.84 (-7.79) ***
MS	0.32 (6.81) ***	0.30 (6.45) ***
MG	0.09 (8.02) ***	0.10 (8.34) ***
CRATIO	-------	-18.96 (-5.67) ***
GAPCHG	-------	11.63 (9.36) ***
NONPERF	-------	54.14 (11.83) ***
Adjusted – R^2 F-Statistic	0.87 730.00 ***	0.89 945.10 ***

Notes: The dependent variable is r_{Index}. T-ratios are in parentheses. (*** denotes significant at the 1 percent level). The 35 coefficients for the time dummy variables are not included in this table.