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Bank Imputed Interest Rates: Unbiased Estimates of Offered Rates?

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Abstract

We examine whether "imputed" interest rates obtained from bank financial statements are unbiased estimates of "offered" interest rates that the same banks report in surveys. We find evidence of a statistically significant amount of bias. However, the statistical bias that we document does not appear to be economically significant. When used as dependent variables in regression analysis, imputed rates and offered rates lead to the same policy conclusions. Our work has important methodological implications for empirical research that examines the product market competition among depository institutions.

Key words: deposit rates, transactional rates, imputed prices, product market, competition

JEL codes: G21, L11

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1. Introduction

Analysis of product market competition in the banking and finance literature (and more generally, in the industrial organization literature) has critical public policy implications. It aids antitrust analysis, for example, in determining whether proposed bank mergers will adversely affect consumers through increased market concentration. The theory models on which this analysis is based refer to prices that the banking firm offers to its customers given the structure of the market it faces. Likewise, the empirical literature examines the statistical relationship between the banking product prices and market concentration. This line of research uses deposit and loan interest rates as dependent or explanatory variables. Those prices are, however, a topic of contention. Prices are difficult to measure and in the banking research, as is the case in most fields of economic research, transaction prices are difficult to obtain. The alternative is to impute prices, that is, to calculate prices by taking the ratio of interest expenses (revenue) to the stock of deposits (loans). However, imputed prices, which incorporate measurement error, may incorporate bias that affects the results of empirical analyses.

In this paper, we examine whether "imputed" (calculated) interest rates are suitable estimates of "offered" (transaction) interest rates using a set of U.S. banks for which both rates are observable. What we term as "offered" rates are those explicitly stated by banks in surveys, and we assume that the offered rates are indeed the "true" interest rates to which the theory models refer.[1] Many researchers, however, rely on interest rates that are imputed from the financial statements because offered rates are either only observable for a limited sample of banks or simply not observable. Even when observed, offered rates may not be readily accessible because they are collected through surveys that are either confidential or sold by private data providers.[2] This contrasts with imputed interest rates which are calculated using

[1] We discuss whether such an assumption is warranted later in the paper.

[2] In the U.S., interest rate survey data collected by the Federal Reserve System, such as the Monthly Survey of Selected Deposits or the Survey of the Terms of Lending, remain confidential. Access is limited to economists working for one of the federal banking regulators. Data from private data providers, such as the Bank Rate Monitor, are available at a non-trivial cost.

information provided in the financial statements. While financial statements, and as a result, imputed interest rates, are available at no cost for the population of U.S. banks, these constructed variables may involve significant measurement error that could lead to systematic bias. Whether such bias exists and, if it exists, whether it affects empirical model estimates are questions that have not been systematically explored.[3] In this paper, our goal is to determine whether using imputed rather than offered interest rates leads to any statistically and economically significant bias. We focus on deposit accounts, rather than loans, because the former have more standard product characteristics than the latter.[4]

Our work has important methodological implications for large strands of empirical research on depository financial institutions. Our results provide evidence of statistically significant bias: the raw imputed deposit rates are not particularly good estimates of the stated interest rates that banks offer to their customers. However, the observed bias decreases when imputed rates are winsorized or truncated, with the truncation being more effective than the winsorization. Once the imputed rate data have been truncated, they become more suitable estimates of the offered rates. Moreover, the observed statistical bias is not economically significant. We show that the coefficient estimates obtained when either imputed or offered rates are used as dependent variables have the same sign, same order of magnitude and the same order of statistical significance. The important implication of our work is that, when properly adjusted for measurement error, imputed interest rates lead to the same policy conclusions as offered rates. The paper proceeds as follows: section 2 presents the data, section 3 provides a short survey of the relevant literature, section 4 presents our empirical analysis, and section 5 concludes.

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[3] Hannan and Prager (1999) touch on this in their work. We discuss their paper below.

[4] Loans are significantly more heterogeneous intermediation products than deposits. This holds true even for more standardized lending contracts, such as mortgages. Although it is possible to observe and control for some of the price and non-price loan characteristics in the loan survey data that are available (such as the Survey of the Terms of Lending), it is not possible to create imputed rates for homogeneous loan categories using Call Reports due to lack of detail at the product level. Moreover, loans' differing maturities make it difficult to compare imputed loan rates with lending rates offered to customers.

2. Data on Offered Rates and Imputed Rates

We combine data from three different sources. Imputed deposit interest rates are calculated using data from the Consolidated Reports of Condition and Income (the Call Reports), the publicly available quarterly financial statements that all U.S. commercial banks file with their federal regulators. We impute rates for three types of deposit accounts for which information is available in the Call Reports: Negotiable Order of Withdrawal (NOW) accounts, Money Market Deposit Accounts (MMDA), and passbook savings accounts. NOW accounts, first introduced in 1980, are interest paying withdrawal-upon-demand checking accounts with minimum balance requirements. MMDA accounts, first introduced in 1982 by banks to compete with the Money Market Mutual Funds, pay higher interest rates than NOW accounts but have more restrictive check-writing privileges and higher minimum balance requirements than NOW accounts.[5] Passbook savings accounts are traditional household saving instruments without check-writing privileges.[6]

The imputed rates are calculated for each of the three account types by dividing the quarterly interest expense in the Call Reports by the stock of deposits for that quarter. It should be noted that the Call Report deposit expense items do not include any other fees or expenses related to deposit account management.[7] We use two measures of quarterly imputed rates. The first of these is based on the latest stock of deposits of the corresponding account type at the current quarter's end, and the second is based on the average of deposits over the quarter.[8] The survey offered rates are stated as simple (non-

[5] Prior to the introduction of NOW and MMDA accounts, checking accounts did not pay explicit interest in the U.S. By 1984, the start of our sample period, both types of accounts were among the standard banking products.

[6] We exclude certificates of deposits (CDs) and negotiable certificates of deposits (NCDs), which are non-checkable savings accounts with specific maturities, from our analysis. Although interest rates on these instruments are included in the MSSD survey, there are no corresponding interest expense items in the Call Reports that are detailed enough to impute maturity-specific CD rates.

[7] Our focus, similar to most of the empirical banking literature, is on explicit interest rates. Implicit rates paid on deposits (in the form of service flows, such as the number checks or transfers allowed per month) and fees that depositors are charged are excluded from our analysis. Note that, since we match imputed rates that we calculate for a particular bank with the offered rates by the same institution, differences in implicit interests or fees charged across banks do not affect our analysis.

[8] The stock of deposits is stated in Schedule RC-E of the Call Reports and the quarterly average is reported in Schedule RC-K of the Call Reports.

compounded) annual percentage rates. To make the quarterly imputed rates comparable with the annual offered rates, we multiply the quarterly imputed rate by four to obtain a simple annual rate.[9]

NOW, MMDA and savings account interest rates offered by banks are collected from the Federal Reserve System's Monthly Survey of Selected Deposits (MSSD), available to us starting with January 1987. The MSSD stopped collecting offered interest rate information in September 1994 and was discontinued in 1997.[10] The survey respondents were asked to provide the most commonly offered interest rate on the largest volume of deposits per deposit type during the last week of each month.[11] The MSSD provided offered-rate data at the bank rather than at the bank and market (or branch) level. Because the MSSD data sampling frequency is higher than the reporting frequency of the Call Reports, we use two alternative measures: the survey rates from the last month of the quarter and the average of monthly survey rates for the quarter.

We also collect market structure variables from the Federal Deposit Insurance Corporation's (FDIC) annual Summary of Deposits datasets, and market level personal income data from the Bureau of Economic Analysis' Regional Economic Information database.

An additional survey data set is currently available to researchers, the Bank Rate Monitor (BRM) data. The BRM is a survey provided by a private data vendor that collects bank and market level data on a weekly basis. Due, however, to substantial reporting issues which render these deposit prices incomparable with Call Report imputed prices, we do not use the BRM data. The primary issue is that the BRM Survey asks participating banks to provide the rates for the banks' "lowest minimum to open" non-interest checking account and "lowest minimum to open and earn interest" checking account. Thus, the

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[9] Note that the resulting imputed rate is based on interest paid, which is compounded interest. Since the Call Reports do not include any information regarding the frequency of the compounding periods (which varies across banks from monthly to semi-annual) we do not make any further adjustments to imputed rates. As it will be seen below, despite this error, our imputed rates slightly underestimate the offered survey rates.

[10] Until end of June 1989, MSSD collected the most commonly offered rate per account type. Starting with July 1989, MSSD surveys collected more detailed NOW and MMDA information that accounted for the possibility that the bank may offer higher rates for larger maintained-balances. For consistency in our data series, we filtered these data to collect only the most commonly observed offered rate per account type. Samples available to us end in September 1994, because after that date MSSD started to collect interest *expense* information, instead of interest *rate* information.

[11] Arguably, offered interest rate per *number* of accounts is a better definition for "most common" than one based on the dollar volume of deposits, but MSSD opts for the latter rather than the former.

rates stated in the BRM data are effectively the lowest rates offered by banks, not the most-commonly cited rates (the mode) as in the MSSD data or the imputed average interest rate paid by the bank (the mean) obtained from the Call Report data. Moreover, BRM does not provide information on the percentage of deposits that earn the lowest rates, nor information on rates paid to accounts with greater deposit balances. As a result, we cannot infer the mean or the mode of the rate distribution from BRM data. In summary, as no additional information on the distribution of the BRM deposit rates is available that would allow researchers to infer the central tendencies of the surveyed rates, we conclude that the use of BRM data in analysis would provide ambiguous results.[12]

3. Literature Survey

Given the methodological focus of this paper, we confine our literature survey to the studies, namely the Structure Conduct Performance (SCP) tests, that have examined the relationship between local market concentration and deposit interest rates where either the offered or the imputed interest rates have been used as dependent variables. In section 4.3, we test whether using imputed versus offered rates in tests of market concentration and deposit rates leads to economically different results. The SCP paradigm implies a relationship between market concentration and firm conduct (in terms of profit or performance); such that noncompetitive behavior in more concentrated markets results in a positive (negative) relationship between market concentration and profitability (deposit prices).

While early studies examined the relationship between market concentration (as measured by the Hirschman Herfindahl Index) and profitability, Berger and Hannan (1989) was the first to test the price-market concentration relationship using MSSD offered rates rather than testing the profit-concentration relationship. The authors' results strongly support the SCP hypothesis when MMDA, NOW and short-

[12] We examined the BRM surveyed NOW and MMDA rates between January 1998 and December 2000 and compared them with the corresponding imputed rates obtained from the Call Reports. For the said period, BRM rates were significantly lower than the corresponding imputed rate. For NOW accounts mean (median) BRM rate was 1.23% (1.01%) compared to mean (median) Call Report imputed rate of 2.56% (1.64%) for the same banks over the same period. For MMDA accounts BRM rate mean was 2.29% (median 2.25%) compared to 3.14% (3.14%) for imputed rates.

term CD rates are used as measure of deposit account prices. Most of the studies that followed using the MSSD data confirm this negative relationship between deposit rates and market concentration (Calem and Carlino (1991), Berger and Hannan (1991)), though not without exceptions (for example, Jackson (1992)). Other studies using MSSD data examine how banks change the rates they offer depositors (Neumark and Sharpe (1992)), and whether the relationship between market concentration and deposit rates holds when concentration changes due to mergers (Prager and Hannan (1998)) or bank branching restrictions (Calem and Nakamura (1998)). A recent study by Brewer and Jackson (2004) considers the effects of including bank-specific risk variables (which capture nonperforming loans, capital and the interest-rate sensitivity of assets and liabilities) in the SCP analysis.

Another set of studies use imputed deposit rates obtained from the Call Report data (Heitfield and Prager (2002), Rosen (2003), Dick (2002), Hannan and Prager (2004) and Hannan and Prager (2006)) and find results generally consistent with studies using the MSSD data. These more recent studies contribute to the literature by testing additional aspects of the SCP paradigm. Rosen (2003), for example, examines whether the size distribution of banks in a market (in addition to market concentration) affects the deposit rates. Heitfield and Prager (1998) test the price-concentration relationship using alternative measures of markets (defined at the Metropolitan Statistical Area or MSA and state-level) and find that while local market concentration measures are useful, broader concentration measures are also appropriate. Several of the studies comment on the advantage of using the imputed Call Report prices given the extended time period for which these data are available (e.g., Rosen (2003), Heitfield and Prager (1998)).[13]

What differs among these studies is the particular interest rate that is found to have the strongest relationship (in terms of statistical significance), and the economic implications of the results. Berger and Hannan (1989) find that MMDA rates are 25 to 100 basis points less in the most concentrated markets than in the least concentrated markets. They find similar results for NOW and savings account rates, but

[13] To date, only a few studies to date have used the Bank Rate Monitor data, partly due to its inaccessibility to researchers and academics until recently. These studies, however, have not been direct tests of the SCP hypothesis. Radecki (1998) and Heitfield (1999) examine the appropriate size of the ‘local-market’; Rosen (2002) presents a model of price setting in the presence of heterogeneous customers; and Kiser (2003) studies whether conditions in the bank loan market affect the pricing of retail deposits.

not for longer-term CD rates. Calem and Carlino (1991) use MMDA and short-term CD rates (3 and 6 months) and find similar results, though they do not interpret the economic effects of their findings. Berger and Hannan (1991) focus solely on MMDA rates and find an asymmetric relationship between rate increases and decreases: a 29 basis point decrease in the rate of market treasuries leads to 62 percent probability that a bank will reduce its MMDA rate. The same increase in market rates leads to a 39 percent probability that a bank will increase its MMDA rate.

Neumark and Sharpe (1992) use MMDA and 6 month CD rates and find that the rates, on average, drop 60 basis points between the least to most concentrated markets. Rosen (2003) includes MMDA and NOW accounts also, and finds a small 4 to 7 basis point change in rates with a one standard deviation change in the market concentration. He attributes a larger change in deposit rates to market size than market concentration. Brewer and Jackson (2004) find that the magnitude of the relationship between deposit rates and market concentration decreases by 50 percent when bank-specific risk variables are included in the SCP analysis.

In summary, most studies use MMDA or NOW accounts, find strong statistical significance using MMDA accounts, less so using NOW accounts and find vastly different economic implications for the results. What is not evident is whether the different economic results found using different rates depend on the additional elements included in later studies (i.e., market size, megamergers) or the dataset and specific rates used. We examine this issue in tests of the SCP hypothesis below.

The only study that examines whether using MSSD offered rates versus Call Report imputed rates may lead to different inferences is Prager and Hannan (1999). In an earlier paper, Prager and Hannan (1998), the authors used MSSD *offered* rates and found that substantial horizontal mergers lead to statistically significant decreases in NOW and MMDA rates (24 and 32 basis point decreases, respectively). When revisiting this evidence using Call Report *imputed* rates (which results in significantly larger samples), Prager and Hannan (1999) find that large horizontal mergers have no effect on NOW and MMDA accounts, whereas such mergers lead to a small decrease in savings account rates (9 basis points).[14] Prager and Hannan (1999) then investigate whether this discrepancy is due to the data source upon which each study relies. They repeat their analysis for a subsample of banks for which both offered and imputed rates are available, and find that coefficient estimates differ significantly depending on whether monthly MSSD offered rates or quarterly Call Report imputed rates are used. The authors note that the coefficient estimates have the same sign but they do not necessarily have the same statistical significance. Further, the authors find that the coefficients of correlation between offered and imputed series range between 0.731 and 0.933 for NOW accounts and 0.515 and 0.689 for MMDA accounts. The authors conclude Call Report imputed prices are "noisy" and "should be used with caution."

Our study differs from theirs in a number of dimensions. First, the Prager and Hannan (1999) analysis is limited to a comparison of the coefficient estimates of their model when offered or imputed rates are used as dependent variables. In contrast, we provide formal tests of the bias analyzing the direction and the size of the potential bias. Second, we discuss the reasons why the observed difference may exist in the two series. Third, Prager and Hannan (1999) use all of the monthly survey interest rate observations and the quarterly imputed series that are available to them when estimating their empirical model. In contrast, throughout our analysis we include only those banks that have both available offered and imputed interest rates. Our approach allows us to compare the differences in standard errors while the estimates are based on the same exact number of observations for the same banks in the same quarters.

Finally, a number of studies examine the effects that the presence of multimarket (i.e., larger, regional or national banks) may have on local market competition, specifically the impact on small single-market banks (community or rural banks). Cohen and Mazzeo (forthcoming) assess competition among financial institutions in rural markets by differentiating among different types institutions (single-market banks, multimarket banks and thrifts). The authors find that heterogeneous institution types affect competition and profitability and conclude that analysis of market concentration should address this differentiation. Berger, Dick, Goldberg, and White (forthcoming) find similar results. These authors

[14] Savings accounts were not analyzed in Prager and Hannan (1998).

examine how competition from large, multimarket banks affects the performance of small, single-market banks in the same markets and how that competition changed over time. The authors find that technical progress enabled large multimarket banks to compete more effectively against small single-market banks in the 1990s. This finding did not hold with large banks that remained in a single market. Results of these studies provide strong support for conducting robustness checks on a sample of single-market banks, rather than examining both multimarket and single market banks together.

4. Empirical Analysis

We conduct three sets of tests to examine whether imputed deposit rates are representative of the deposit rates that banks offer to customers. First, we examine the distributions for the imputed and offered rates for different types of deposit accounts. Second, we test the null hypothesis that imputed interest rates are unbiased estimates of rates that banks offer by regressing offered deposit rates on their imputed counterparts in cross-sectional OLS regressions. In this step, we also examine whether winsorizing or truncating helps reduce any statistical bias that may exist. Finally, to examine whether observed statistical differences have any impact on empirical estimations, we estimate separate SCP regressions where the dependent variable is first the offered deposit rate and then the imputed deposit rate.

4.1 Alternative measures of imputed and offered rates

The MSSD is a monthly survey. Thus, we use the offered rates from last survey of the quarter (where R_MSSD_END denotes the MSSD rate at the quarter's end) and an average of the monthly surveyed deposit rates during the quarter (R_MSSD_AVE, where AVE denotes quarterly average of the MSSD rate). Included in our MSSD dataset are offered interest rates from 1987 to 1994 for three types of accounts: NOW, MMDA and savings accounts.

The two Call Report imputed rates that we use in our analysis are (1) the ratio of the end-of-quarter deposit expense (for each account type) divided by the end-of-quarter stock of deposits for the corresponding account type and quarter (R_CR_END) and (2) the ratio of the end-of-quarter deposit expense (for each account type) divided by the average stock of deposits over the quarter (R_CR_AVE).

4.2. Descriptive Statistics and Univariate Tests

In Table 1 Panel A we provide detailed distribution information on all of the interest rate series that we use in our analysis. The imputed rates obtained from the Call Report contain extreme outliers. Maxima and minima presented in Panel 1A. MSSD survey rates also contain interest rates that are too small or too high, suggesting that the survey data, too, contain outliers.

One method to minimize the effect of such extreme observations on the empirical analysis is to winsorize the variable in question by assigning the tail observations to a specified percentile of the data. We assign the observed values below the 1^{st} and above 99^{th} (5^{th} and 95^{th}) percentiles of the distribution, to the values of the 1^{st} and 99^{th} (5^{th} and 95^{th}) percentiles, respectively. Alternatively, one could truncate the series by dropping observations that are lower or higher than a given threshold at either end of the distribution. Each of these methods, however, has its weaknesses. While both methods preserve the central tendency of the distribution for the variable in question, truncation throws out valuable observations whereas winsorization assigns arbitrary values to observations that fall outside of the set threshold.

Panel 1A suggests that the large discrepancies observed in the tails of the distributions between R_MSSD and R_CR series are attenuated when we move to the 5^{th} and 95^{th} percentiles of series' distributions. The 25^{th}, 50^{th} and 75^{th} quartile observations show relatively smaller differences. We, therefore, work with data series that are winsorized or truncated at 1^{st}–99^{th} or 5^{th}–95^{th} percentiles. The tests that we conduct provide guidance whether winsorize or truncate and at what level. While higher levels of winsorization or truncation are certainly possible, we do not consider them here as it would lead to the loss of valuable data points and are unlikely to be adopted by researchers.

In Panel 1B, we test the statistical significance of the observed differences that we observe in Panel 1A for selected pairs of survey and imputed rate series that are winsorized at the 1^{st}–99^{th} percentiles of their distributions (first three columns of Panel 1B) or truncated at the 5^{th}–95^{th} percentiles (last three columns). The t-tests of the equality of the means are rejected in all of the cases at the 1 percent level (except for the truncated savings account rates rejected at the 5 percent level). The equality of the variances (the variance ratio test) is also rejected at the one percent level for all six pairs of series that we examine. The rank-order correlations range between 0.51 to 0.89, and are the lowest for savings account series and the highest for the NOW account series. These results suggest that, even though the survey and imputed rate series that we examine are highly positively correlated, they may incorporate important differences that might lead to imputed rates being biased estimates of survey rates.

The results of Table 1 provide evidence of statistically significant differences between the offered rates obtained from MSSD data and the corresponding imputed rates obtained from the Call Report data (for the same set of banks in the same quarters).

There are a number of reasons why the imputed rates would not be good estimates of the offered rates. The imputed rates, a ratio of the interest expense and the stock of deposits, are affected by error in either component. Such errors include data entry errors, rounding issues, and reporting errors which may distort the imputed rate. Data entry errors are uncommon, but do exist. Such errors include: entries with an incorrect number of zeros, and general typos (reporting the wrong numbers or putting them in the wrong item number). All dollar amounts entered into the Call Reports are rounded to the nearest $1,000. Thus, rounding issues are of greater concern for smaller banks which may end up having less accurate imputed rates. A number of reporting errors are likely to affect either the interest expense or the stock of deposits reported by banks. In reporting the interest expense, for example, banks are instructed to deduct from gross interest expense any penalties for early withdrawals or portions of such penalties that represent the forfeiture of interest accrued or paid to the date of withdrawal. This accounting requirement would reduce the amount of net interest expense reported by any bank that had early withdrawals.

Next, we investigate to what degree researchers of financial institutions should consider winsorization or truncation of imputed rates obtained from bank financial statements. Following this, we examine whether these observed differences generate biases of which researchers should be aware.

4.3. Winsorization versus Truncation of the Offered and Imputed Deposit Rates

These outliers, attributed to reporting errors, rounding errors, and mismeasurement, are substantial. Specifically, the MSSD-based MMDA offered rates range between 0.01% and 15.48%, whereas the corresponding raw imputed rates range between –60.53% and 216.05%. Similar outliers are observed for all of the offered and imputed deposit rate series in our samples.

To examine the effects of different levels of winsorization and truncation, we regress the winsorized (truncated) offered rate series on winsorized (truncated) imputed rate series with the same level of winsorization or truncation:

$$\text{R\_MSSD}_{\text{i,t}} = \alpha + \beta \ \text{R\_CR}_{\text{i,t}} + \varepsilon_{i,t} \,, \tag{1}$$

where $\text{R\_MSSD}_{\text{i,t}}$ is the offered rate collected from the MSSD survey, and $\text{R\_CR}_{\text{i,t}}$ is the corresponding Call Report imputed interest rate. We use 1^{st}-99^{th} and 5^{th}-95^{th} percentile thresholds when winsorizing or truncating. In regression (1), if imputed rates are unbiased estimates of the offered rates, the null hypothesis requires that α=0 *and* β=1.[15]

The OLS regression estimates of equation (1) for NOW accounts are presented in Table 2.[16] The left-hand-side of Table 2 presents results using the quarter-end rate for the survey data (R_MSSD_CR) and imputed rates based on the stock of NOW accounts at the end of the quarter (R_CR_END). The null hypothesis (H_0: α=0 and β=1) is rejected in Table 2. The F-test results are provided at the bottom of the table. When using the imputed rates winsorized at the 1^{st}-99^{th} percentile of their distribution, we obtain estimates of $\hat{\alpha}$ =0.0135 and $\hat{\beta}$=0.6594. Truncating at the same threshold

[15] This null hypothesis is in fact a joint-hypothesis since it presumes that offered transaction rates are the "true" interest rates in which researchers are interested.

[16] We repeat the analysis using MMDA and savings account rates, but to conserve space, we do not to report these results.

level, we obtain estimates of $\hat{\alpha}$ =0.0094 and $\hat{\beta}$ =0.7644. Moving the threshold to the 5th-95th percentiles and winsorizing the series yields $\hat{\alpha}$ =0.0064 and $\hat{\beta}$ =0.8473, whereas truncating at the latter level yields $\hat{\alpha}$ =0.0040 and $\hat{\beta}$ =0.9183. The regression R^2s systematically increase from 0.6333 to 0.8088. These results indicate that truncation at the higher threshold (5th-95th percentiles of the imputed rate distribution) provides a better fit than the other options tested. However, the null hypothesis of no bias (H_0: α=0 and β=1) is rejected for all four regressions.

In the right-hand side of Table 2, we repeat the above analysis by regressing the average of rates surveyed in a given quarter (R_MSSD_AVE) on imputed rates that were calculated based on the average stock of deposits during the same quarter (R_CR_AVE). The results show that the bias is reduced in all of the regressions when compared with their counterparts on the left-hand side of Table 2. The coefficient estimates for the series winsorized at the 1st-99th percentiles are now $\hat{\alpha}$ =0.0073 and $\hat{\beta}$ =0.8343 with an R^2 of 0.7895. The coefficient estimates for the series truncated at the 5th-95th percentiles are $\hat{\alpha}$ =0.0026 and $\hat{\beta}$ =0.9627 with an R^2 of 0.8857. Despite a lower $\hat{\alpha}$ and a higher $\hat{\beta}$, the null hypothesis of no bias is still rejected in all of the regressions.

We conclude that survey rates and imputed rates truncated at the 5th and 95th percentiles of their distribution show the least amount of statistical bias. In the next section, we repeat this analysis and check the robustness of our results for rates on other account types.

4.4. Robustness Checks

In this section, we examine first whether the results observed for NOW accounts in Table 2 also hold for MMDA and savings accounts. We find that they do not. Columns 1 and 2 of Panel 3A repeat columns 4 and 8 of Table 2, respectively, for NOW accounts, while columns 3 and 4 of Panel 3A present the results for MMDA accounts.[17] A sharp increase in the bias appears with regard to the MMDA rates results. As column 3 shows, regressing R_MSSD_END on R_CR_END for MMDA accounts yields $\hat{\alpha}$=0.0280 and $\hat{\beta}$=0.4863 with an R^2 of 0.3408 (compared to $\hat{\alpha}$=0.0038 and $\hat{\beta}$=0.9244 and an R^2 of 0.8107 for the comparable NOW account rates in the first column). Regressing R_MSSD_AVE on R_CR_AVE (column 4) yields $\hat{\alpha}$=0.0227 and $\hat{\beta}$=0.5832 with an R^2 of 0.4622. The observed bias is higher yet in the case of savings account rates (column 6); where $\hat{\alpha}$=0.0325, $\hat{\beta}$=0.3689 and R^2=0.2964. Not surprisingly, the null hypothesis of no bias is strongly rejected in all of the cases in Panel 3A. When we repeat our bias regressions with the interest rate variables winsorized or truncated at 1st and 99th percentiles, we find larger bias (we do not report these results to conserve space).

Given the discrepancy in the bias tests between the NOW accounts versus the MMDA and savings accounts, we examine whether the observed differences hold in different subsamples. Specifically, we explore whether these discrepancies hold across (i) multimarket versus single-market banks (which may potentially explain the observed differences if NOW account rates have less dispersion than the MMDA or savings account rates for multimarket banks) and (ii) urban (MSA) versus rural banks. The results presented in panels 3B and 3C show that the results observed in Panel 3A for the overall sample also hold for the above-mentioned subsamples. NOW account rates show the least amount of bias.

In Panel 3B, we re-estimate regression (1) for multimarket and single-market banks with the series that show the least amount of bias (rates based on averages truncated at the 5th and 95th percentiles). The results for multimarket banks are very similar to those for single-market banks. For example, multimarket bank NOW account rates (column 1 of Panel 3B) yield estimates of $\hat{\alpha}$=0.0024

[17] The number of observations for the NOW account regressions differs slightly between Tables 2 and 3. We restrict the regressions in Table 3 (for all account types) to contain observations for which the end of quarter rates and average of the quarter rates are available for each bank. This allows better comparison of the bias inherent in either end or average rates for each account type.

and $\hat{\beta}$=0.9752, with R^2=0.8755. The single-market bank NOW account rates (column 4) yield $\hat{\alpha}$ =0.0027, $\hat{\beta}$=0.9599 and R^2=0.8982. Similar results hold for the MSSD and savings account rates.

We also examine whether the bias differs between urban (MSA) versus rural banks, two subsamples that researchers typically examine separately due to the differences in these markets' characteristics. In results presented in Panel 3C, we observe that the amount of bias (always statistically significant) remains about the same for banks operating in these two different types of markets for NOW and MMDA accounts. In the case of savings accounts, the bias for rates reported by urban banks is larger than the bias associated with the rates reported by rural banks.

These results suggest that there are no major discrepancies in the way imputed rates relate to survey rates when one compares the multi- versus single-market banks or urban versus rural banks. However, the bias is *statistically* significant for all rates considered in the different subsamples that we examined. What holds across these tests is that the observed bias is the smallest for NOW accounts, much larger for MMDAs, and even larger for savings accounts.

A number of reasons exist as to why the observed bias may differ across account types. The larger biases observed for MMDA and savings accounts may be due to the fact that banks are more likely to offer rate schedules tiered by deposit amount for MMDA and savings accounts than for NOW accounts. If so, then the offered schedules for MMDA and savings accounts would incorporate more dispersion than those for NOW accounts and mode of the distribution collected by the MSSD may be less representative of the distribution of rates for MMDA and savings accounts than it is for NOW accounts.

Another possible source of discrepancy is the minimum amount that is required for the payment of interest. Banks typically impose such minimum thresholds, and these are likely to be higher for MMDA and savings accounts than they are for NOW accounts. If so, MMDA and savings accounts may carry proportionally larger number of accounts that carry non-interest earning balances because they fell below the interest-earning threshold required by the bank.

Despite these data errors and issues, the existence of statistical bias need not result in economically different inferences when imputed rates are used instead of offered rates. We test this conjecture next.

4.5. Imputed Deposit Rates versus Offered Deposit Rates in SCP Analysis

In this section, we compare the results of deposit price-market concentration regressions to determine whether using imputed interest rates instead of the offered interest rates leads to different conclusions in studies of the relationship between market concentration and prices (or tests of the SCP Hypothesis). While the scope of this test is limited to a specific case, it is relevant because deposit price information has been commonly used in SCP analysis. We conduct regressions based on equation (2) below and present the results in Table 4:

$$\mathrm{R}_{\mathrm{i,t}} = a + b_1 HHI_{i,t} + b_2 MSA_{i,t} + b_3 HHI_{i,t} \times MSA_{i,t} + b_4 PIPC_{i,t} + \sum_{t=1}^{T} c_t D_t + e_{i,t}\,, \qquad (2)$$

where $\mathrm{R}_{\mathrm{i,t}}$ is the deposit-account specific offered or imputed interest rate (R_MSSD or R_CR, respectively), HHI is the Herfindahl-Hirshman Index of market concentration (calculated for each market once a year due to the availability of Summary of Deposits data), MSA is dummy variable that equals 1 for metropolitan markets and 0 otherwise, and PIPC is the personal income per capita in the market in question (in constant beginning-of-sample-period dollars, scaled by $10,000). Deposit markets are defined as the largest of a county, a Metropolitan Statistical Area (MSA) or a Consolidated-MSA (CMSA). We interact the HHI variable with the MSA "dummy" to capture the potential differences in market concentration that may prevail in rural and urban markets. This interaction captures the marginal effect of an increase in concentration given that market concentration tends to be higher in rural markets (DeYoung, Goldberg and White, 1999). Finally, we account for time variation in deposit rates by including time "dummy" variables (D_{t}) for each quarter except the first.

We first present the results using the series that exhibited the highest amount of bias in Table 2, the offered rates from the last survey of the quarter (R_MSSD_END) and the corresponding imputed rate

(R_CR_END), both winsorized at the 1st and 99th percentiles of their distributions. The results of the SCP regressions using the MSSD data are presented in Panel 4A. The coefficient estimate for HHI is –0.0033 (statistically significant at the 1 percent level) when the NOW account *offered* rate (R_MSSD_END) is used as the dependent variable. This result is consistent with previous studies. When the NOW account imputed rate (R_CR_END) is used, however, the coefficient for HHI (–0.0035) has the expected sign, but is not statistically significant. The HHI interacted with MSA is positive and statistically significant in two of the offered rate regressions (the NOW account and savings account rates), but is not significant in any of the three imputed rate regressions. A positive sign on the HHI*MSA coefficient suggests that an increase in market concentration in urban (MSA) markets results in marginally lower deposit rates than in a non-MSA market.

While the coefficient estimates are similar, the standard errors are larger when Call Report imputed rates are used as the dependent variable. Indeed, all of the standard errors in column 2 (where R_CR_END is the dependent variable) are larger than their counterparts in column 1 (where R_MSSD_END is the dependent variable). This is not surprising, as the Call Report rates (the R_CR) presumably incorporate larger measurement error; and hence larger standard errors. Importantly, the measurement error in the dependent variable does not lead to a bias or inconsistent estimates but to less efficient estimates.

The results for the MMDA accounts (columns 3 and 4) and savings accounts (columns 5 and 6) are similar; we find variation in the coefficient estimates between offered (R_MSSD) and imputed (R_CR) rates, with the standard errors being larger in the case of the latter. The coefficient on HHI is not statistically significant for regressions using MMDA rates.

Results of SCP regressions for the series that exhibit the least amount of bias are presented in Panel B of Table 4. This panel contains the average of rates surveyed over the quarter (R_MSSD_AVE) versus imputed rates based on average deposits during the quarter (R_CR_AVE) and truncated at the 5th and 95th percentiles of their distributions. In general, the results using the two data sets are more similar in this panel than in Panel A. The coefficient estimates and standard errors are comparable between the offered and imputed rates, and, consequentially, the signs and statistical significance of the coefficients would, in all cases but one, lead to like policy conclusions. A quick comparison of the two panels of Table 4 yields the following observations: First, in Panel 4B the discrepancy across coefficient estimates in columns 1 and 2 is much smaller, as are the standard deviations for the coefficient estimates. For example, in column 1 the coefficient estimate for HHI is equal to –0.0019 (with a standard error of 0.0013), in column 2 the corresponding coefficient estimate is –0.0012 (with a standard error of 0.0014). Again, neither of these coefficients is statistically significant. As in Panel A, the observed discrepancies for the same coefficient estimates are larger in the other columns as MMDA and savings account rate series exhibit larger biases. Even in those cases, however, the coefficient estimates in the SCP regressions for offered and imputed rates are similar and exhibit the same signs and significance levels; the coefficient on HHI is not significant in any of the regressions, but the coefficient on HHI*MSA is statistically significant in the regressions using the NOW imputed or offered rates. We find one notable difference in this set of regressions: HHI*MSA is significant in the regression using the savings account offered rate, but not the savings account imputed rate.

Based on these results, we recommend that researchers use the imputed series based on the average stock of deposits during the quarter and truncate the obtained variable at the 5th and 95th percentiles of its distribution.   This choice would lead to coefficient estimates that are qualitatively similar to those that obtained from survey data, with the caveat that the former would have larger standard errors due to measurement error.[18]

As Prager and Hannan (1999) note, imputed interest rates are noisy estimates of offered (transaction) deposit rates. However, our work shows the importance of truncation and suggests that the

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[18] While these findings and conclusions seemingly contradict Prager and Hannan (1999), a number of discrepancies between the Prager and Hannan (1999) study and our study exist. First, Prager and Hannan (1999) estimate a model of price *changes* that compares pre- and post-merger prices whereas we estimate a SCP model in the price *levels*. Second, Prager and Hannan (1999) estimate the same model using *monthly* MSSD offered rates and *quarterly* Call Report imputed rates for the same time horizons. Thus the offered rate regressions would have a higher number of observations, and hence lower standard errors, than the regressions in which quarterly Call Report imputed rates are used. Conversely, our comparisons of offered versus imputed rates use the same number of observations in each of these regressions.

coefficient estimates obtained using the imputed rates (properly constructed and truncated) leads to analogous policy conclusions.

5. Summary and Conclusions

In this paper, we provide a systematic analysis of the bias that imputed interest rates may introduce when used as estimates of offered interest rates. Our results provide strong evidence of statistical bias. Imputed interest rates tend to underestimate the true interest rates offered to customers for the same account type at the same bank. We further examine whether this observed bias leads to economically different results in analyses that researchers conduct. Reassuringly, we find that this is not the case; typically the coefficient estimates have the same signs, same levels of statistical significance, and are of the same order of magnitude irrespective of whether imputed or offered rates are used. This suggests that imputed rates are suitable estimates of offered (transaction) rates when conducting empirical research. An important implication of our research is that empirical analyses of bank price data need not remain limited to survey data as imputed rates from the Call Reports are available for the population of U.S. banks.

References

Adams, Robert M., Kenneth P. Brevoort and Elizabeth K. Kiser. (forthcoming). "Who Competes with Whom? The Case of Depository Institutions." Journal of Industrial Economics

Berger, Allen N., Astrid A. Dick, Lawrence G. Goldberg and Lawrence J. White. (forthcoming). "Competition from Large, Multimarket Firms and the Performance of Small, Single-Market Firms: Evidence form the Banking Industry," *Journal of Money, Credit, and Banking.*

Berger, Allen N. and Timothy H. Hannan. (1989). "The Price-Concentration Relationship In Banking," *Review of Economics and Statistics* 71(2): 291-299.

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

Brewer, Elijah III and William E. Jackson III. (2004) "The 'Risk-Adjusted' Price-Concentration Relationship in Banking." Federal Reserve Bank of Atlanta Working Paper 2004-35.

Calem, Paul S. and Gerald A. Carlino. (1991). "The Concentration/Conduct Relationship in Bank Deposit Markets," *Review of Economics and Statistics* 73(2): 268-276.

Calem, Paul S. and Leonard I. Nakamura. (1998). "Branch Banking and the Geography of Bank Pricing," *Review of Economics and Statistics* 80(4): 600-610.

Cohen, Andrew and Michael J. Masseo. (2005). "Investment Strategies and Market Structure: An Empirical Analysis of Bank Branching Decisions." Working Paper.

Cohen, Andrew and Michael J. Masseo. (forthcoming). "Market Structure and Competition Among Retail Depository Institutions." *Review of Economics and Statistics.*

DeYoung, Goldberg, and White. (1999). "Youth, Adolescence and Maturity of Banks: Credit Availability to Small Business in an Era of Banking Consolidation," *Journal of Banking & Finance 23:* 463-492.

Dick, Astrid. (2002). "Demand Estimation and Consumer Welfare in the Banking Industry," Board of Governors of the Federal Reserve System Working Paper 2002-58.

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

Hannan, Timothy H. (1991). "Bank Commercial Loan Markets and the Role of Market Structure: Evidence from Surveys of Commercial Lending", *Journal of Banking and Finance* 15: 133-149.

Hannan, Timothy H. (1997). "Market Share Inequality, The Number Of Competitors, And The HHI: An Examination Of Bank Pricing," *Review of Industrial Organization* 12(1): 23-35.

Hannan, Timothy H. (2002). "The Impact of Credit Unions on the Rates Offered For Retail Deposits by Banks and Thrift Institutions," Board of Governors of the Federal Reserve System Working Paper 2002-06.

Hannan, Timothy H. (2006). "Retail Deposit Fees and Multimarket Banking," *Journal of Banking and Finance 30*(9): 2561-78.

Hannan, Timothy H. and Allen N. Berger. (1991). "The Rigidity of Prices: Evidence from the Banking Industry," *American Economic Review* 81(4): 938-945.

Hannan, Timothy H. and Robin A. Prager. (2006). "Multimarket Bank Pricing: An Empirical Investigation of Bank Deposit Interest Rates," *Journal of Economics and Business* 58(3):256-72.

Hannan, Timothy H. and Robin A. Prager. (2004). "The Competitive Implications of Multimarket Bank Branching," *Journal of Banking and Finance* 28(8): 1889-1914.

Heitfield, E.A. (1999). "What Do Interest Rate Data Say About the Geography of Retail Banking Markets?" *The Antitrust Bulletin* 44(2) 333-347.

Heitfield, Erik A. and Robin A. Prager. (2002). "The Geographic Scope of Retail Deposit Markets." Board of Governors of the Federal Reserve System Working Paper 2002-49.

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

Kiser, Elizabeth K. (2004). "Modeling the Whole Firm: The Effect of Multiple Inputs and Financial Intermediation on Bank Deposit Rates." Board of Governors of the Federal Reserve System Working Paper 2004-07.

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

Prager, Robin. A. and Timothy H. Hannan. (1998). "Do Substantially Horizontal Mergers Generate Significant Price Effects? Evidence from the Banking Industry," *The Journal of Industrial Economics* 46(4): 433-452.

Prager, Robin A. and Timothy H. Hannan. (1999). "The Price Effects of Horizontal Mergers in the Banking Industry: Some Further Evidence," Working Paper.

Radecki, Lawrence J. (1998). "The Expanding Geographic Reach of Retail Banking Markets," *Federal Reserve Bank of New York Economic Policy Review* (June) 15-33.

Rhoades, Stephen A., and Roger D. Rutz, (1982). "Market Power and Firm Risk: A Test of the 'Quiet Life' Hypothesis," *Journal of Monetary Economics* 9: 73-85.

Rosen, Richard J. (2002). "What Goes Up Must Come Down? Asymmetries and Persistence in Bank Deposit Rates." Journal of Financial Services Research 21 (3): 173-193.

Rosen, Richard J. (2002). "Banking Market Conditions and Deposit Interest Rates." Federal Reserve Bank of Chicago Working Paper 2003-19.

Table 1. Summary Statistics and Univariate Tests

Panel A presents distributional information on Monthly Survey of Selected Deposits (MSSD) survey rates and Call Report (CR) imputed rates. END refers to MSSD series based on the last survey of quarter and CR series based on the stock of deposits at the end of the same quarter. AVE refers to MSSD series based on the average of surveyed rates during the quarter and CR series based on the average stock of deposits during the quarter. Panel B presents tests of equality of the means (t-test with H_0: $mean_X - mean_Y = 0$), tests of equality of the variances (F-test with H_0: $var_X \div var_Y = 1$). And rank-order correlations (ρ) for selected pairs of series from Panel A. * and ** denote statistical significance at the 5% and 1% levels, respectively.

Panel 1A			N	Minimum	1st percentile	5th percentile	25th percentile	Median	75th percentile	95th percentile	99th percentile	Maximum
NOW Accounts	1987Q2-1994Q2	**R_MSSD_END**	14,445	0.0001	0.0120	0.0151	0.0275	0.0470	0.0505	0.0550	0.0608	0.1548
		R_CR_END	14,445	–0.8296	0.0098	0.0155	0.0275	0.0439	0.0502	0.0617	0.1027	1.3333
		R_MSSD_AVE	14,445	0.0014	0.0122	0.0161	0.0285	0.0470	0.0509	0.0548	0.0608	0.1528
		R_CR_AVE	14,445	–1.9801	0.0097	0.0155	0.0273	0.0443	0.0499	0.0570	0.0782	1.0000
MMDA	1987Q1-1991Q2	**R_MSSD_END**	8,339	0.0350	0.0450	0.0495	0.0525	0.0550	0.0600	0.0710	0.0800	0.1150
		R_CR_END	8,339	–0.0771	0.0245	0.0466	0.0534	0.0576	0.0635	0.0747	0.0975	1.3333
		R_MSSD_AVE	8,339	0.0350	0.0460	0.0494	0.0525	0.0553	0.0600	0.0708	0.0794	0.1050
		R_CR_AVE	8,339	–0.0967	0.0262	0.0479	0.0533	0.0570	0.0629	0.0741	0.0925	1.7770
Savings Accounts	1987Q1-1991Q2	**R_MSSD_END**	8,442	0.0400	0.0425	0.0450	0.0500	0.0510	0.0550	0.0575	0.0737	0.0895
		R_CR_END	8,442	–0.8703	0.0223	0.0415	0.0485	0.0512	0.0547	0.0691	0.1157	0.4727
		R_MSSD_AVE	8,442	0.0386	0.0425	0.0450	0.0500	0.0516	0.0550	0.0576	0.0733	0.0892
		R_CR_AVE	8,442	–0.8387	0.0224	0.0431	0.0492	0.0514	0.0549	0.0690	0.1186	1.1104

Panel 1B		Rates *Winsorized* at 1st & 99th Percentiles				Rates *Truncated* at 5th & 95th Percentiles			
		R_MSSD_END	R_CR_END	tests		R_MSSD_AVE	R_CR_AVE	tests	
NOW Accounts	Mean	0.0404	0.0408	–2.44	**	0.0408	0.0396	7.94	**
	Standard Deviation	0.0134	0.0161	0.69	**	0.0118	0.0115	1.05	**
	Rank-order correlation (ρ)			0.82	**			0.89	**
MMDA	Mean	0.0571	0.0588	–13.02	**	0.0562	0.0574	–13.64	**
	Standard Deviation	0.0068	0.0099	0.47	**	0.0046	0.0053	0.74	**
	Rank-order correlation (ρ)			0.59	**			0.69	**
Savings Accounts	Mean	0.0520	0.0527	–5.63	**	0.0515	0.0514	–1.80	*
	Standard Deviation	0.0044	0.0113	0.15	**	0.0027	0.0040	0.46	**
	Rank-order correlation (ρ)			0.51	**			0.64	**

Table 2. Winsorize or Truncate the Deposit Rates?

This table presents the results of the following OLS regression for unbalanced panels of U.S. commercial banks:

$$R\_MSSD_{i,t} = \alpha + \beta \; R\_CR_{i,t} + \varepsilon_{i,t} \qquad (1)$$

The dependent variable is the interest rate that the bank has most commonly offered for NOW accounts and reported in the last survey of the quarter. The explanatory variable is the imputed interest rate for NOW accounts obtained from the Call Reports for the same bank in the same quarter. All equations are estimated using OLS with Huber-White standard errors (reported in parentheses below coefficient estimates) for clustering across banks. F-statistics are reported for the joint-null hypothesis that α=0 and β=1. * and ** denote significance at the 5% and 1% levels, respectively.

NOW Account Rates	$R\_MSSD\_END_{i,t} = \alpha + \beta R\_CR\_END_{i,t} + \varepsilon_{i,t}$								$R\_MSSD\_AVE_{i,t} = \alpha + \beta R\_CR\_AVE_{i,t} + \varepsilon_{i,t}$							
	R_MSSD winsorized at 1%		**R_MSSD truncated at 1%**		**R_MSSD winsorized at 5%**		**R_MSSD truncated at 5%**		**R_MSSD winsorized at 1%**		**R_MSSD truncated at 1%**		**R_MSSD winsorized at 5%**		**R_MSSD truncated at 5%**	
Constant	0.0135 (0.0009)	**	0.0094 (0.0008)	**	0.0064 (0.0005)	**	0.0040 (0.0003)	**	0.0073 (0.0005)	**	0.0044 (0.0003)	**	0.0044 (0.0004)	**	0.0026 (0.0003)	**
R_CR winsorized at 1%	0.6594 (0.0244)	**							0.8343 (0.0132)	**						
R_CR truncated at 1%			0.7644 (0.0212)	**							0.9083 (0.0087)	**				
R_CR winsorized at 5%					0.8473 (0.0112)	**							0.9158 (0.0084)	**		
R_CR truncated at 5%							0.9183 (0.0076)	**							0.9627 (0.0057)	**
H_0: α = 0 & β = 1	118.9	**	95.1	**	99.8	**	72.9	**	105.7	**	105.0	**	88.9	**	95.3	**
Bank-quarter obs.	14,446		13,912		14,446		12,564		14,973		14,393		14,973		12,751	
Number of banks	735		730		735		720		737		735		737		721	
R^2	0.6333		0.7175		0.7760		0.8088		0.7895		0.8542		0.8528		0.8857	
Regression F-stat	731.4	**	1296.5	**	5680.7	**	14702.3	**	4007.8	**	10981.0	**	12015.4	**	28312.8	**

Table 3. Tests of Statistical Bias

This table presents the results of the following OLS regression for unbalanced panels of U.S. commercial banks:

$$\text{R\_MSSD}_{i,t} = \alpha + \beta \ \text{R\_CR}_{i,t} + \varepsilon_{i,t} \quad (1)$$

The dependent variable is the interest rate that the bank has most commonly offered for a particular type of deposit account. We use either the rate from the last survey of the quarter or the average of rates in all surveys of the quarter. The explanatory variable is the imputed interest rate obtained from the Call Reports. We use either the stock of deposits as reported at the end of the quarter or the average stock of deposits through the quarter (as reported in Schedule K of Call Reports). All imputed rates are truncated at 5% of either side of their distributions. All equations are estimated using ordinary least squares (OLS) with Huber-White standard errors for clustering across banks. F-statistics are reported for the joint-null hypothesis that α=0 and β=1. T-statistics appear in parentheses. * and ** denote significance at the 5% and 1% levels, respectively.

Panel 3A (all rates truncated at 5th & 95th percentile of their distributions)

	NOW Accounts				MMDA				Savings Accounts			
	R_MSSD_END		**R_MSSD_AVE**		**R_MSSD_END**		**R_MSSD_AVE**		**R_MSSD_END**		**R_MSSD_AVE**	
Constant	0.0038	**	0.0026	**	0.0280	**	0.0227	**	0.0336	**	0.0325	**
	(0.0003)		(0.0003)		(0.0009)		(0.0011)		(0.0011)		(0.0015)	
R_CR_END	0.9244	**			0.4863	**			0.3490	**		
	(0.0077)				(0.0169)				(0.0205)			
R_CR_AVE			0.9641	**			0.5832	**			0.3689	**
			(0.0058)				(0.0196)				(0.0280)	
H_0: α=0 & β=1	68.3	**	97.1	**	462.2	**	230.4	**	511.2	**	255.0	**
# of bank-quarter obs.	11,967		11,967		6,646		6,646		6,914		6,914	
# of banks	714		714		619		619		614		614	
R^2	0.8107		0.8858		0.3408		0.4622		0.2655		0.2964	
Regression F-stat	14509.2	**	27475.3	**	828.0	**	884.5	**	289.8	**	173.2	**

Table 3. Tests of Statistical Bias (continued)

Panel 3B

Multimarket Banks vs. Single-Market Banks

$$R\_MSSD\_AVE_{i,t} = \alpha + \beta \; R\_CR\_AVE_{i,t} + \varepsilon_{i,t}$$

(all rates are truncated at the 5th & 95th percentile of their distributions)

	Multimarket Banks						Single-Market Banks					
	NOW		MMDA		Savings Accounts		NOW		MMDA		Savings Accounts	
Constant	0.0024	**	0.0271	**	0.0363	**	0.0027	**	0.0282	**	0.0392	**
	(0.0004)		(0.0022)		(0.0018)		(0.0004)		(0.0023)		(0.0028)	
R_CR_AVE	0.9756	**	0.5049	**	0.2901	**	0.9599	**	0.4901	**	0.2470	**
	(0.0087)		(0.0379)		(0.0346)		(0.0086)		(0.0408)		(0.0534)	
H_0: α=0 & β=1	55.4	**	112.9	**	210.0	**	41.1	**	87.5	**	100.9	**
# of bank-quarter obs.	6,265		3,537		3,574		4,563		2,746		2,861	
# of banks	394		322		318		348		290		284	
R^2	0.8755		0.3940		0.2255		0.8982		0.4010		0.1848	
Regression F-stat	12538.5	**	177.8	**	70.1	**	12441.7	**	144.4	**	21.4	**

Panel 3C

Urban (MSA) vs. Rural Market Banks

$$R\_MSSD\_AVE_{i,t} = \alpha + \beta \; R\_CR\_AVE_{i,t} + \varepsilon_{i,t}$$

(all rates are truncated at the 5th & 95th percentile of their distributions)

	Urban (MSA) Market Banks						Rural Market Banks					
	NOW		MMDA		Savings Accounts		NOW		MMDA		Savings Accounts	
Constant	0.0024	**	0.0275	**	0.0383	**	0.0030	**	0.0287	**	0.0303	**
	(0.0003)		(0.0018)		(0.0018)		(0.0007)		(0.0038)		(0.0029)	
R_CR_AVE	0.9712	**	0.5002	**	0.2565	**	0.9509	**	0.4737	**	0.4159	**
	(0.0068)		(0.0307)		(0.0344)		(0.0156)		(0.0678)		(0.0572)	
H_0: α=0 & β=1	83.4	**	163.3	**	236.8	**	13.4	**	33.8	**	53.5	**
# of bank-quarter obs.	9,140		5,325		5,441		1,688		958		994	
# of banks	558		479		474		106		90		88	
R^2	0.8880		0.3926		0.1929		0.8657		0.4113		0.3241	
Regression F-stat	20449.2	**	264.6	**	55.7	**	3736.0	**	48.8	**	52.9	**

Table 4. Imputed Vs. Offered Rates in Structure Conduct Performance Analysis

$$R_{i,t} = a + b_1 HHI_{i,t} + b_2 MSA_{i,t} + b_3 HHI_{i,t} \times MSA_{i,t} + b_4 PIPC_{i,t} + \sum_{t=1}^{T} c_t D_t + e_{i,t} \quad (2)$$

The dependent variable is either (i) the MSSD offered interest rate (R_MSSD) or (ii) the Call Report imputed rate (R_CR). HHI is the Herfindahl-Hirshman Index of market concentration. MSA is a "dummy" variable for metropolitan markets. PIPC is the personal income per capita (in constant-beginning-of-sample-year dollars). OLS regressions control for clustering at the bank level using Huber-White standard errors. T-statistics appear in parentheses below the estimated coefficients. * and ** denote statistical significance at the 5% and 1% levels, respectively.

Panel 4A — **MSSD Offered Rates versus CR Imputed Rates in SCP Regressions**

(all rates winsorized at 1st & 99th percentile of their distributions)

	NOW				MMDA				Savings Accounts			
	R_MSSD_END		**R_CR_END**		**R_MSSD_END**		**R_CR_END**		**R_MSSD_END**		**R_CR_END**	
Constant	0.0250	**	0.0225	**	0.0508	**	0.0553	**	0.0482	**	0.0458	**
	(0.0016)		(0.0025)		(0.0014)		(0.0016)		(0.0014)		(0.0031)	
HHI	–0.0033	*	–0.0035		–0.0018		–0.0015		–0.0003		0.0041	
	(0.0015)		(0.0027)		(0.0024)		(0.0026)		(0.0015)		(0.0048)	
MSA	–0.0020	*	–0.0035	*	–0.0014		–0.0007		–0.0002		0.0002	
	(0.0009)		(0.0016)		(0.0013)		(0.0015)		(0.0008)		(0.0019)	
HHI×MSA	–0.0067	*	–0.0042		–0.0020		–0.0034		–0.0065	**	–0.0087	
	(0.0028)		(0.0045)		(0.0038)		(0.0047)		(0.0025)		(0.0061)	
PIPC (in $10,000)	–0.0008		0.0002		0.0030	**	0.0017		0.0015	**	0.0013	
	(0.0005)		(0.0008)		(0.0007)		(0.0009)		(0.0005)		(0.0009)	
Quarter dummies	yes		yes		yes		yes		yes		yes	
# of bank-quarter obs.	10,956		10,956		6,348		6,348		6,343		6,343	
# of banks	589		589		511		511		511		511	
R^2	0.8609		0.6213		0.2553		0.1742		0.0641		0.0268	
Regression F-stat	406.2	**	268.0	**	50.2	**	61.8	**	10.8	**	18.3	**

Table 4. Imputed Vs. Offered Rates in Structure Conduct Performance Analysis (continued)

The dependent variable is either (i) the MSSD offered interest rate (R_MSSD) or (ii) the Call Report imputed rate (R_CR). HHI is the Herfindahl-Hirshman Index of market concentration. MSA is a "dummy" variable for metropolitan markets. PIPC is the personal income per capita (in constant-beginning-of-sample-year dollars). OLS regressions control for clustering at the bank level using Huber-White standard errors. T-statistics appear in parentheses below the estimated coefficients. * and ** denote statistical significance at the 5% and 1% levels, respectively.

Panel 4B **MSSD Offered Rates versus CR Imputed Rates in SCP Regressions**

(all rates truncated at 5th & 95th percentile of their distributions)

	NOW				MMDA				Savings Accounts			
	R_MSSD_AVE		**R_CR_AVE**		**R_MSSD_AVE**		**R_CR_AVE**		**R_MSSD_AVE**		**R_CR_AVE**	
Constant	0.0255	**	0.0250	**	0.0476	**	0.0486	**	0.0496	**	0.0500	**
	(0.0013)		(0.0015)		(0.0013)		(0.0014)		(0.0010)		(0.0012)	
HHI	–0.0019		–0.0012		0.0005		0.0008		–0.0004		–0.0009	
	(0.0013)		(0.0014)		(0.0021)		(0.0020)		(0.0015)		(0.0015)	
MSA	–0.0017	*	–0.0018		–0.0001		0.0002		–0.0002		–0.0011	
	(0.0008)		(0.0009)		(0.0009)		(0.0009)		(0.0007)		(0.0008)	
HHI×MSA	–0.0057	*	–0.0066	**	–0.0029		–0.0031		–0.0053	*	–0.0042	
	(0.0024)		(0.0025)		(0.0030)		(0.0031)		(0.0021)		(0.0026)	
PIPC (in $10,000)	–0.0003		–0.0001		0.0021	**	0.0017	**	0.0006		0.0007	
	(0.0005)		(0.0005)		(0.0005)		(0.0005)		(0.0004)		(0.0005)	
Quarter "dummies"	yes		yes		yes		yes		yes		yes	
# of bank-quarter obs.	9,763		9,763		5,746		5,746		5,887		5,887	
# of banks	579		579		514		514		503		503	
R^2	0.8800		0.8215		0.2671		0.2607		0.0626		0.0354	
Regression F-stat	414.9	**	372.3	**	39.9	**	53.7	**	7.7	**	6.9	**

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