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Bank net interest margins, the yield curve, and the 2007-2009 financial crisis

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Abstract: Using quarterly call report data from 2000 to 2016, we reexamine the relationship between net interest margins (NIM) and the yield curve for more than 5,500 U.S. commercial banks. In the full sample, yield curve and RGDP growth have positive effects on NIM, while inflation and deposit-to-loan ratios (D/L) have negative effects. Splitting the sample around the 2007-2009 crisis, we show the impact of yield curve and RGDP growth on NIM increasing during the "recovery" (2009Q3 to 2016Q4), and inflation and D/L changing signs. Positive effects of yield curve on profits vary with bank size and change over time.

Keywords: Bank profitability, financial crisis, macroeconomics, panel data, yield curve.
JEL Classification Numbers: E44, G21.

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1. Introduction

By the summer of 2007, the fallout of the U.S. housing market led banks to report considerable losses and substantial write downs of their real estate portfolios due to rising delinquencies and reductions in home values. Factors that contributed to the softening of the housing market included increasing interest rates between 2003 and 2006 and a greatly reduced pool of qualified homeowners.[1] Furthermore, during this time period, market capitalization of the major banks became significantly depleted, contributing to the banking turmoil. The ensuing U.S. financial crisis led to unprecedented government intervention by the U.S. Federal Reserve and the U.S. Treasury in an attempt to revive the financial system. During the financial crisis period, bank lending was modest as banks focused on rebuilding liquidity on their balance sheets. Bank lending to some degree was curtailed by their exposure in real estate portfolios. The effects of the 2007-2009 financial crisis have subsided and bank profitability, for the most part, has been restored.

There are, of course, many factors that influence bank profitability. Not only business cycles but also institutional guidelines regarding lending and competition in the industry could be particularly important. The academic literature reviewed below has evidence on bank profits responding to interest rates (and other macroeconomic factors), as well as to bank-related measures, such as: assets, deposits to loan ratios, mortgage portfolios, etc. Perhaps one of the most relevant terms behind bank profitability is the yield curve. The mechanism is well-known in the financial press, such as during the recent U.S. presidential election of November 2016, which led to a substantial market upward response in bond yields: U.S. 10-year benchmark, for

[1] The rate rise, however, may have been less than would have been required had the U.S. Federal Reserve followed interest rate rules more closely: "To understand why reform is needed, recall that the Fed moved away from a rules-based policy in 2003-05 when it held the federal funds rate well below what was indicated by the favorable experience of the previous two decades. The results were not good…" Taylor (2016).

example, moved from 1.7%-1.8% to about 2.3% in a couple of weeks, amid a sell-off in bonds and a boom in all stock markets. Here is one very recent example summarizing the conventional wisdom on the yield curve and bank profit margins: “A move higher in interest rates and a steeper yield curve … suggest bank profits should improve. More relief could be on the way if the Federal Reserve again increases short-term rates in December. And any move to undo or lessen regulation could allow banks to return more capital to investors, which in turn would boost returns on equity. That would lead to higher profits and could argue for higher valuation multiples, some analysts believe.” (Ensign, The WSJ, November 16, 2016). While often used in the financial press, there is not to - our knowledge - an effort of quantifying the yield curve on bank profits.

The literature surrounding the financial crisis has taken various paths focusing on government intervention (e.g., Cecchetti (2009) and Taylor and Williams (2009)), balance sheet adjustments of financial intermediaries (e.g., He et al. (2010) and Adrian and Sung (2010)), bank lending and credit availability (e.g., Cornett et al. (2011), Egly and Mollick (2013), Apergis and Christou (2015), and Kosak et al. (2015)), and consequences of expansionary monetary policy for equity markets (e.g., Huang et al. (2016)). Another stream of research re-examines theories of financial intermediation (e.g., Shleifer and Vishny (2010), and Acharya et al. (2010)) and investigates equity markets’ reaction to government regulation enacted in response to the financial crisis (e.g., Peristian et al. (2010) and Subrahmanyam et al. (2011)). To acquire an overall economic perspective of the government intervention, Veronesi and Zingales (2010) calculate the costs (i.e. cost to tax-payers) and benefits (i.e. increased value of banks’ financial claims) of the government bailout and conclude it was an overall success. They contend that from an economic viewpoint the government intervention created value by preventing a run on banks and by providing capital that reduced banks' inefficiencies related to excessive leverage.

An interesting area of research which has not received much attention deals with how economic forces impact bank profitability after the 2007-2009 financial crisis. This paper examines the role of the yield curve on bank net interest margins (a measure of bank profitability) while controlling for other macro-forces and bank-level characteristics. This study explores the following research questions: 1) Does bank balance sheet structure and/or bank size play a role in banks' net interest margin behavior in response to changes in the yield curve?; 2) Has bank profitability, captured through net interest margins, been restored to pre-crisis levels?; and 3) What has been the impact of the yield curve on bank net margins during a period of unprecedented government intervention and U.S. expansionary monetary policy? Examining the impact of economic forces on bank profitability is particularly appealing given the significant transformation in financial intermediation, the gradual shift in sources of bank revenue (i.e. interest income vs. fee income), and the path of the yield curve over the time frame of our study which covers periods of economic expansion and contraction. The banking turmoil and the subsequent 2007-2009 financial crisis motivate the importance of understanding the main elements of bank profitability. The motivation for this research is also driven by the recent Basel III Accord. Using data from 1990 to 2007 for several industrial countries, Bolt et al. (2012) claim that the Accord urged banks to retain additional profits and payout fewer dividends when Tier 1 capital buffers are below required levels. Revisiting how the yield curve impacts bank profitability is important since the overall functioning and wellbeing of the U.S. economy hinges on a stable financial system with well-capitalized profit-generating financial institutions operating in an economy with historically low interest rates since the 2007-2009 financial crisis.

This paper contributes to the literature as follows. First, it complements the body of research in the financial press that offers viewpoints on the impact of the yield curve on bank profits largely based on circumstantial evidence. Our paper studies the profit behavior of U.S. banks during a period of significant transformation in the banking system, in which the key driving force of profits remains the price of lending long and borrowing short.

Second, in contrast to previous studies, this research covers a sample period from 2000Q1 to 2016Q4, which includes the mild recession of 2001, economic expansion (including the peak and subsequent bust of the housing bubble), the 2007-2009 global financial crisis, and economic recovery. During the time frame of this study, we witnessed major swings in the yield curve. This invites a re-assessment of the relationship between the key variable of interest and bank net interest margins especially in light of shifts in bank's sources of revenues over the years and swings in the U.S. economy captured by real GDP growth, as documented by Stiroh (2004). Using annual call report data from 1978 to 2000, he finds that greater reliance on non-interest income, particularly trading revenue, is associated with lower risk-adjusted profits and higher risk.

Third, the work by Bolt et al. (2012) combines theory and evidence of bank behavior. This paper borrows their empirical framework but moves focus to the U.S. banking system examining individual bank quarterly data, while their work examines both individual and aggregate bank annual data for 17 countries. The sample period in our work extends beyond theirs (from 1990 to 2007) to capture the recession of 2007-2009 that led short-term interest rates to zero, looks at four different asset classes of banks, and combines macro factors along with bank controls to explain net interest margins. In this way, we apply panel data methods to a very large number of U.S. banks following a four-size classification scheme based on asset size that yields 4,981 small banks, 475 medium banks, 34 large banks, and 14 money-center banks to examine sensitivity of bank profitability to fluctuations in the yield curve. This represents an important departure from existing studies at quarterly frequency that typically considers a small number of largest banks. For the U.S., for example, at quarterly frequency and under a similar time span than ours it is possible to mention the 10 commercial banks studied by Apergis and Cooray (2015) and 16 retail banks examined in the theoretical model by Egan et al. (2017). In addition to the full sample covering 2000Q1 through 2016Q4, also modeled are two important subsample periods; the first subsample "initial period" runs from 2000Q1 through 2009Q2 (June 2009 marks the end of the U.S. recession according to the NBER) while the second subsample, identified as a "recovery period", starts in 2009Q3 and ends in 2016Q4.

Controlling for bank balance composition (namely deposits-to-loans) and macro forces, our findings show that the yield curve has a positive effect on bank net interest margins that varies with bank size. We also find that the yield curve's effect on bank net interest margins changes across time with greater impact during the recovery period compared to the initial period. For all banks, real GDP growth positively impacts bank net interest margins over the full sample period. The effect of real GDP on bank net interest margins also increases during the recovery period.

We present evidence that important shifts in the yield curve are mirrored by changes in net interest margins, albeit of lesser magnitude for the smaller bank samples when compared to the larger bank samples. We also document that net interest margins have been fairly stable for the small and medium bank samples, yet generally decline for the large and money-center bank samples in the post crisis period, an era of unparalleled U.S. government intervention and U.S. expansionary monetary policy.

The remainder of this paper is organized as follows. Section 2 describes the data sources and presents descriptive statistics. Section 3 introduces the empirical models, along with our working hypotheses. Section 4 discusses the results and Section 5 summarizes our conclusions.

2. The Data and Descriptive Statistics

The sample draws from the population of commercial banks that are insured through the Federal Deposit Insurance Corporation (FDIC) over the time period 2000Q1 to 2016Q4. The bank information is compiled in Consolidated Reports of Condition “call reports” that are submitted quarterly by insured banks. The bank data used for this study are available through Federal Deposit Insurance Corporation statistics on depository institutions (SDI) database at the following website: http://www2.fdic.gov/sdi/index.asp (last accessed on 5/14/17).

Since this research deals with bank-level data, data is drawn from the lead bank in the case of multibank holding companies (BHC). In many instances the lead bank commonly represents over 80% of the total insured assets reported by the BHC.[2] Banks with missing balance sheet and/or income information required for this study are excluded from the sample. Following Loutskina (2011), this research applies several qualifiers to the population of commercial banks to minimize the impact of outliers. We eliminate all bank-quarter data with asset growth over the preceding quarter in excess of 50%, total loan growth exceeding 100%, and total loans-to-assets ratio of less than 10%. By applying these qualifiers to the population of FDIC insured commercial banks, 192,408 bank quarter observations are removed from the initial data set with the final full sample containing 319,927 bank quarters.

The bank information extracted for this study includes: 1) net interest margin computed as total interest income less total interest expense divided by average earning assets, 2) total assets,

[2] To investigate the presence of multibank holding companies, we extract a list of the largest 150 financial institutions as of the beginning of the sample. We match each of these institutions against the FDIC website to determine if they are BHC. The number of banks excluded that form part of a BHC represents less than 2% of the total sample. The lead banks of BHC are retained for this research.

3) total loans, and 4) FDIC insured domestic deposits less than $100,000.[3] To examine behavior patterns of the commercial banks across asset sizes, the sample is decomposed into various subsample classifications following Verma and Jackson (2008). The bank sample is divided into four groups based on average total asset size as of beginning of period as follows: small banks (average total assets < U.S. $1 billion), medium banks (average total assets ≥ U.S. $1 billion and < U.S. $20 billion), large banks (average total assets ≥ U.S. $20 billion and < U.S. $90 billion) and money- center banks (average total assets ≥ U.S. $90 billion).[4]

Two important subsample periods are considered; the first covers 2000Q1 through 2009Q2 (June 2009 represents the end of the 2007-2009 U.S. recession) and the second starts on 2009Q3 and runs through 2016Q4. The first subsample period covers an important time span that encompasses the tail-end of the economic boom period of the 1990s, the U.S. stock market crash of 2000 and the burst of the dot-com bubble, the 9/11 terrorist attacks of 2001, the housing bubble and subsequent bust in the summer of 2007, major oil price hikes in international markets during 2008, and the 2007-2009 credit crisis. Our second subsample, which runs from 2009Q3 through 2016Q4, is identified as our "recovery" period. During this time frame although we have witnessed short term interest rates at near zero levels and generally declining long term interest rates, economic growth (measured through real GDP) has been admittedly modest. In addition, pieces of legislation, such as Dodd-Frank in 2010, were passed towards the banking system signaling more regulation.

[3] The deposit threshold for FDIC reporting purposes increased to $250,000 effective September 2009. Due to the change in FDIC deposit threshold coverage, SDI reporting of insured deposits was also revised (SDI variable code name "depsmamt" replaced with "iddepsam").

[4] It is plausible that some banks that meet this minimum size indicator at the beginning of the sample period could fall below the minimum threshold especially during the 2007-2009 financial crisis period in which some banks experienced heavy losses and large write downs in their real estate portfolios. We choose to retain in the sample those banks that may fall below the size threshold in any given quarter since it is not anticipated that these banks in the near term would necessarily make major changes to their funding sources or their business model.

Table 1 Panels A through E presents descriptive information on the banks classified as small, medium, large, and money-center, and for all banks combined for our full sample and two subsample periods. For example, Panel A comprises the small banks subsample, in which Panel A.1 has the full sample, A.2 has the first subsample (2000Q1 to 2009Q2) and A.3 has the second subsample (2009Q3 to 2016Q4). Panels B, C, and D do the same for other class sizes, and panel E reports all banks together.

Some interesting results emerge under this bank classification scheme. The dependent variable in our regression models (net interest margin) declines modestly as overall bank size increases over our full sample period (refer to Panels A.1, B.1, C.1, and D.1). Within each bank size classification, mean net interest margins are on a downward trend with money-center and small banks (large and medium banks) experiencing the greatest (least) net interest margin erosion. For example, the mean net interest margin for money-center banks exhibits a decline of close to 50 basis points (0.510%) from 3.454% in the initial period as shown in Panel D.2 to 2.944% in the recovery period as reported in Panel D.3. The medium, large and money-center bank samples are reporting increasing volatility (measured through the difference in magnitudes of standard deviations) during the recovery period compared to the initial period while the small bank sample shows declining volatility in NIMs.

Overall these findings suggest that funding sources differ as bank size changes (i.e. a shift from less expensive “core deposits”, usually a key funding source for smaller banks, towards more expensive, and rate sensitive, “purchased funds”, which largely support money-center bank activities). The alternative maturity strategies commonly employed by banks for managing their investment portfolios may help explain the difference in net interest margin volatility patterns.

There are some important differences in the balance sheet mix between smaller and larger banks. When scaled by mean total assets, banks' exposure to loans declines as overall bank size rises for our full sample period (e.g. the ratio of total-mean-loans-to-mean-assets is 65% for small banks calculated from Table 1 Panel A.1 compared to 50% for money-center banks from Table 1 Panel D.1). This finding is consistent with the view that the type of activities banks engage is normally influenced by bank size. For example, small banks usually focus on the retail side of banking while large banks tend to emphasize wholesale banking. Examining the data between the initial and recovery periods within each bank size classification, we see that the ratio of total-mean-loans-to-mean-assets is generally declining suggesting a liquidity build-up by banks (e.g. this pattern is most noticeable in the money-center bank sample). The liquidity build up by all bank groups between the initial and recovery periods is also evidenced by the increase in the ratio of total-mean-deposits-to-mean-assets with the large banks reporting the greatest build up (refer to Table 1 Panel C.2 and C.3) followed by medium and small banks (ratios derived from Table 1 Panels B.2 and B.3, and Panels A.2 and A.3, respectively). The total-mean-loans-to-mean-deposit ratios reveal a downward trend in all bank samples between the initial and recovery periods and are generally larger as bank size increases. This finding supports the view that larger banks typically have greater access to capital and money markets, including repurchase agreement markets compared to their smaller counterparts.

The main variable of interest in our study is the yield curve (maturity risk premium) defined as the difference between the 10-year U.S. Treasury Bond Constant Maturity rate (series GS10) and the 3-month U.S. Treasury Bill rate (series TB3MS) which are in monthly frequency downloadable from the Federal Reserve Bank of Saint Louis: http://research.stlouisfed.org/fred2 (data retrieved on 5/14/2017). The inverted yield curve depicted in Figure 1 (from 2000Q1 to 2000Q4) is consistent with large-scale repurchases of long-term Treasury bonds by the U.S.

Treasury in early 2000 which reduced the supply of bonds and their respective yields. The graph reflects the U.S. economy entering a recessionary period (from 2001Q1 to 2001Q4) highlighted by the burst of the dot-com bubble, a reduction in business investments and outlays, and the September 11th, 2001 terrorist attacks. A second prolonged inverted yield curve begins in 2004Q2 and runs through 2007Q1. This suggests that investors were expecting Fed induced reductions in interest rates in fear of a looming recession. During this time frame, the U.S. economy witnessed staggering growth in residential construction and subprime mortgage lending which created a housing bubble. The quality of the subprime mortgage portfolio led to weak and questionable bank balance sheets which induced banks to hoard liquidity placing upward pressure on interest rates.[5]

Table 1 Panel F provides details on our macroeconomic variables. The mean of the yield curve is close to 2% over the period, but it is lower in the first subsample (1.68%) than in the second (2.39%). The reason the yield curve becomes steeper is that the fall in short-run rates guided by the Federal Reserve's expansionary monetary policies was larger than the fall in long-run rates: the decline in long-run rates was of 200 basis points; the decline in short-run rates was close to 271 basis points! Inflation fell during the crisis and economic growth was higher in the recovery since the first subsample includes the negative growth during the 2007-2009 crisis. If the yield curve helps explain bank profitability, its effect should be higher in the second subsample. Regarding profitability, Table 1, Panels E.1-E.3 shed light on bank data: NIM has mean of 3.931% over the whole sample but that comes with a decline in second subsample: mean of 4.066% in first subsample against 3.740% in second, which likely reflects the increase

[5] The 1- month London Interbank Offered (LIBOR) rate increased from 1.36% at 6/30/04 to 5.32% at 3/30/07- source: Federal Reserve Bank of Saint Louis. The LIBOR is a common benchmark rate used by the world's largest banks for inter-bank short term borrowings.

in the deposit/loan ratio (overall mean of 55.41%) in second subperiod: mean of 47.94% in first subsample against 61.38% in second.

< Insert Figure 1 about here >

Contemporaneous bivariate correlations are computed for the: 1) bank variables, 2) macro variables, and 3) yield curve for the full sample and two subsample periods on banks classified as small, medium, large, and money-center, and for all banks combined[6]. Correlation results suggest that bank behavior is not fully consistent across all subsamples. To illustrate this point, the correlation between net interest margin and deposits-to-loans over our full sample period is negative, yet very small in magnitude for the small, medium bank samples (-0.014 and -0.026, respectively), moderately negative for the large bank sample (-0.129) and moderately positive at 0.252 for the money-center bank sample. Negative correlations become larger in magnitude for small and large banks moving from the initial period to the recovery period, while the positive correlation becomes stronger for money-center banks. These negative correlations suggest that liquidity build-ups (captured through an increase in the ratio of deposit to loans) are accompanied by a contemporaneous decline in net interest margins. This finding is plausible to the extent that excess funds/liquidity are invested in lower yielding assets instead of funding higher earning (and inherently more risky) loan opportunities.

There is a positive, yet weak, co-movement between net interest margins and real GDP growth hovering between 0.028 and 0.038 for the small, medium, and large banks increasing to 0.051 for our money-center banks over the full sample period. Interestingly, in each bank size classification the co-movement either essentially dissipates or turns negative, with values approaching zero in the recovery period. Findings provide some support for the cyclical nature of

[6] The correlation tables for each class of bank sizes are available from the authors upon request. As reported in the text, the correlation coefficients are low to moderate.

price-cost margins as explained by Aliaga-Diaz and Olivero (2011), who report a negative bivariate contemporaneous correlation between net interest margin and real GDP growth albeit of a greater magnitude (e.g. -0.2039 based on U.S. bank quarterly data from 1979-2005). The positive co-movement between net interest margin and real GDP growth captured in our full sample period seems in line with Albertazzi and Gambacorta (2009). They explain that improvements in economic conditions are accompanied by concurrent increases in loan demand and improved financial condition of borrowers with positive effects on the profitability of traditional financial intermediation activities.

Another interesting correlation pattern emerges between net interest margin and the yield curve which varies based on bank size. Over the full sample period, correlation is negative for small and medium banks (-0.074 and -0.032, respectively), near zero for the large banks, and positive, yet small at 0.033 for the money-center banks. The correlation between the net interest margin and the yield curve strengthens for the larger bank samples as we move from the initial period to the recovery period (e.g. from 0.111 to 0.219 for money-center banks) and changes direction for the smaller bank samples (e.g. from -0.045 to 0.037 for small banks).

With the exception of positive correlation between long-term and short-term interest rates variables ranging from 0.786 in the initial period to 0.838 in the full sample period, the yield curve and long term interest rates correlations ranging from -0.319 in the full sample period to 0.980 in the recovery period, and the negative correlations of -0.784 and -0.929 between the yield curve and short term interest rates in the full sample and initial periods (correlation remains negative at -0.314 during the recovery period), all other correlations are either low or moderate. The low-to-moderate correlations help mitigate any potential collinearity issues that could impact the profitability models, noting that in no model we allow the aforementioned highly correlated variables to jointly enter a single model simultaneously.

To explore the impact of real output on bank net interest margins we incorporate a real GDP growth rate (RGDP) variable. RGDP is measured as a quarterly growth rate variable calculated from the GDPC1 series US Real Gross Domestic Product, Billions of Chained 2009 Dollars. This series is of quarterly frequency and seasonally adjusted downloadable from the Federal Reserve Bank of Saint Louis: http:// research.stlouisfed.org/fred2 (data retrieved on, 5/14/2017). Figure 2 our bank profit variable (Net Interest Margin), provides preliminary support to the pro-cyclicality of bank profitability and real output growth as suggested by Bolt et al. (2012). They find that the co-movement between bank profits and real GDP is much stronger during deep recessions compared to normal economic conditions. Our graphs add on this point for U.S. banks and the economy. In Figure 2, NIM is declining overall; only money center banks have a significant upside during the 2007-2009 crisis; this did not happen in 2001 when all categories of banks had NIM increase by the end of the milder recession of 2001.

< Insert Figure 2 about here >

Also included is an inflation rate variable to control for its effects on bank net interest margins. Albertazzi and Gambacorta (2009) suggest that traditional intermediation activity is less profitable during periods of high inflation that penalize lenders; to counter the negative impact, banks tend to redirect their efforts towards fee based activities during inflationary periods. Inflation erodes the real rate of return to investors holding deposits which generates a disincentive. Inflation rate is measured as a quarterly growth rate variable for modeling purposes (expressed in percentage) and constructed from the Consumer Price Index series CPIAUCNS (index 1982-1984=100). The series is of monthly frequency, not seasonally adjusted, and downloaded from the Federal Reserve Bank of Saint Louis: http:// research.stlouisfed.org/fred2 (data retrieved on, 5/14/2017).

3. Methodology

Given the cross-section and time series dimensions of the bank sample data sets, panel estimation techniques are employed to examine the impact of the yield curve on the net interest margin of FDIC insured commercial banks over the period 2000 through 2016. We introduce a profitability model that incorporates bank-specific determinants (deposits-to-loans ratio as described in the preceding Data section) and macro-variables following Bolt et al. (2012). This modeling approach recognizes that net interest income, which is a substantial component of bank profit, depends on the full history of outstanding loan balances and deposits and their respective interest rates. To the extent that higher deposits to loan ratios capture higher levels of bank liquidity, as opposed to loan portfolio build-up, we anticipate an inverse relationship between deposits-to-loans ratios and net interest income. The inverse relationship is consistent with the notion that purchases of large volumes of liquid, readily-marketable securities tend to lower the average yield from a bank's earning assets and reduce its profitability.

The macro-variables used in this model consist of the yield curve, real GDP growth rate, and inflation rate also described in the Data section. The focus on the impact of the yield curve on net interest margins is to validate the common belief that bank managers (lenders) fare better with an upward-sloping yield curve than they do under a horizontal or downward-sloping yield curve. Bank's earning assets (loans and securities) usually tend to exhibit longer maturities than their funding sources (i.e. liabilities). Modern financial theory usually associates upward-sloping yield curves with rising interest rates and economic expansion. Real GDP growth rate is also included since it is commonly used in bank profitability model; see Albertazzi and Gambacorta (2009), Aliaga-Diaz and Olivero (2011), and Bolt et al. (2012). It is anticipated that there is a direct relationship between real GDP growth rate and profitability in line with what has generally been set forth in the literature. Finally, an inflation rate variable is included to account for the potential loss of the purchasing power of interest income and loan repayments given rising prices for goods and services. The direction of the relationship arguably depends on bank management's ability to fully anticipate (and plan for) inflation expectations suggesting that banks can adjust their pricing in order to increase revenues to offset rising costs.

Panel estimation is employed to model the impact of the yield curve on bank net interest margin similar to the empirical specification presented by Bolt et al. (2012). The model is expressed as follows:

$$\Delta y_{i,t} = \sum_{\tau=1}^{4} \beta_{1,t-\tau}\, bk_{i,t-\tau} + \sum_{\tau=1}^{4} \beta_{2,t-\tau}\, macro_{t-\tau} + \sum_{\tau=1}^{4} \beta_{3,t-\tau}\, yc_{t-\tau} + \alpha_i + \varepsilon_{i,t}\,, \quad (1)$$

where the Δ prefix represents the change in the profitability variable y consisting of the net interest margin measured as the difference between total interest income and total interest expense scaled by average bank earning assets; bk denotes our deposits-to-loans variable expressed in ratio form; $macro$ consists of a vector of macro-economic variables, which includes: 1) real GDP growth rate and 2) inflation rate; and yc is the yield curve variable that enters the model in first differences.[7] Finally, α_i represents the bank-specific fixed effects while $\varepsilon_{i,t}$ captures the remaining disturbance term.

[7] Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) unit root tests are applied to all macro variables. The null of these tests is that the series contain unit roots (i.e. non-stationary series). The RGDP growth rate and inflation rate variable series were stationary in their original form; it is noted that the yield curve (yc) variable is non-stationary in levels yet it becomes stationary in first differences. Unit root tests are not reported in this study but are available upon request.

Equation (1) resembles the profitability model introduced by Bolt et al. (2012) while incorporating a few important differences. First, we exclude long-term and short-term interest rates and corresponding interaction terms to reduce multi-collinearity and confounding factors. This is because the yield curve is, by construction, computed from long and short interest rates. We also remove all right hand side contemporaneous terms from the model to reduce potential endogeneity issues. Second, our focus is on the U.S. banking system using individual bank quarterly data while their work explores both individual and aggregate bank annual data for 17 countries. The sample period in this study includes the 2007-2009 financial crisis while their sample period ends in 2007. Third, the primary contribution by Bolt et al. (2012) is to capture the asymmetric effects of the business cycle on bank profitability. Comparing the estimated effect of the yield curve on NIM, relative to other macroeconomic forces and bank data (deposit to loans), our approach attempts to validate the use of the yield curve by banks as an important maturity management tool. Besides, it may serve as a nice "market-based" complement to low-frequency RGDP and bank-specific data alike.

Estimation of our panel model hinges on the assumptions about the intercept (α_i), the slope coefficients (β*'s*), and the error term ($\varepsilon_{i,t}$). Three types of panel data models are considered: pooled, fixed effects, and random effects models. To the extent that there are neither significant bank nor temporal effects, we could pool our data and estimate our model using ordinary least squares. While most of the time there are either differences across units (banks in our case) or temporal effects, it is plausible to encounter instances when neither of these are statistically significant in which case a pooled regression model is appropriate. Fixed effects models have constant slope coefficients and time invariant intercepts that differ according to the cross-sectional unit; in other words, the time invariant intercepts capture the assumed heterogeneity across the banks. The main question/assumption is whether or not the bank-specific effects (α_i) are correlated with the regressors in our model.

As an initial step the model is estimated using fixed effects assuming differences across units are captured by differences in the constant intercept term α_i (our bank-specific fixed effect). This estimation is the preferred panel data technique assuming that z_i (a vector of bank-specific unobserved variables) is correlated with $x_{i,t}$ (the regressors in our model).[8] For example, it is plausible that bank-specific unobserved factors such as managerial ability, credit cultural and credit policy, market share objectives, etc. which presumably impact bank profitability may also be correlated with the bank-specific deposits-to-loans variable. To validate this empirical approach, a series of diagnostic tests are applied. First, F test results from the fixed effects model determine whether there are differences across groups (banks). Second, in the pooled least squares estimations, a Durbin Watson test is applied to detect serial correlation in the residuals. Third, a Breusch-Pagan Lagrange Multiplier (LM) test is used on the random effects model based on the OLS residuals. Fourth, the specification test developed by Hausman (1978) is used to test for the orthogonality of the random effects and the regressors. Under a random effects specification, an important assumption is that unobserved bank-specific effects α_i are uncorrelated with the regressors $x_{i,t}$. Under random effects specification, unobserved bank-specific effects are treated as a random variable (with a mean value of α) similar to $\varepsilon_{i,t}$ except that for each bank there is a single draw that enters the regression identically in each period. See Greene (2003) for details. The results section reports model specifications as supported by the

[8] If z_i is unobserved yet correlated with $x_{i,t}$ the least squares estimator of β is biased and inconsistent due to an omitted variable. However, in the instance where the model is $y_{i,t} = x'_{i,t}\beta + \alpha_i + \varepsilon_{i,t}$ and $\alpha_i = z'_i\alpha$ embodies all observable effects, an estimable conditional mean equation can be specified. See Greene (2003).

above described diagnostic tests.[9]

Our profitability model incorporates some noteworthy features. First, similar to Verma and Jackson (2008), the bank sample is divided into four asset size classes to determine whether bank behavior patterns that are manifested through the banks' balance sheet impact net interest margins differently. Second, up to four lags of right hand variables are allowed. This is especially important with regards to the deposits-to-loans variable since a considerable component of bank profit, rests on the full history of outstanding loan balances and deposits and their respective interest rates. Third, this study allows for the interaction between inflation and deposits-to-loans to capture the indirect impact of inflation on net interest margins through the bank's balance sheet. The purpose behind this interaction term is to determine whether inflationary pressures operate through the bank's balance sheet. For example, banks with high credit risk exposure in their loan portfolios would be expected to hoard more cash (high liquidity risk exposure) compared to bank with lower credit risk exposure in their portfolio during periods of crisis. The need to build liquidity places pressure on net interest margins due to rising liquidity costs which could be further exasperated during a period of rising interest rate expectations (which commonly factor in inflation expectations).

To investigate the impact of the 2007–2009 financial crisis on net interest margins, we expand our benchmark model by adding a crisis dummy variable. The expanded model takes the following form:

$$\Delta y_{i,t} = \sum_{\tau=1}^{4} \beta_{1,t-\tau}\, bk_{i,t-\tau} + \sum_{\tau=1}^{4} \beta_{2,t-\tau}\, macro_{t-\tau} + \sum_{\tau=1}^{4} \beta_{3,t-\tau}\, yc_{t-\tau} + \beta_4 crisis_{t-1} + \alpha_i + \varepsilon_{i,t}, \qquad (2)$$

where the Δ prefix represents the change in the profitability variable y consisting of the net interest margin measured as the difference between total interest income and total interest expense scaled by average bank earning assets as in Equation 1; *crisis* represents a dummy variable that enters the model as an independent regressor with one lag and takes on a value of one during the crisis period from 2007Q4 through 2009Q2 and zero otherwise; and all other right-hand side variables (i.e., *bk, macro, and yc*) are the same as those described in our benchmark model.

[9] As a robustness exercise, we run our bank profitability model applying pooled OLS, fixed effects, and random effects estimation. Central findings remain qualitatively unchanged. For brevity, the fixed effects and random effects estimations are reported only as our diagnostic tests support this panel data approach. Pooled OLS regression results are not reported in this study but are available upon request.

Finally, α_i represents the bank-specific fixed effects while $\varepsilon_{i,t}$ captures the remaining disturbance term.

The growing uncertainty with respect to the value of banks' balance sheets was at the core of the financial crisis and was captured by sharp increases in money market rates. The rising uncertainty about the value of the banks' balance sheets prompted banks to hoard cash as they became concerned about their continued ability to tap into capital markets to cover their funding requirements. To extent that the 2007–2009 financial crisis captures a period of high liquidity and counterparty risks, we would anticipate a negative impact of our crisis variable on net interest margins.

This paper introduces two testable hypotheses as follows. Under the Loanable Funds theory, when a domestic economy experiences a period of growth, market participants are willing to borrow more heavily. Holding all other factors constant, the resulting shift in demand for loanable funds due to economic growth results in an increase in the equilibrium interest rate and an increase in the equilibrium quantity of funds traded. Because banks' loans and asset security holdings tend to have longer maturities than their sources of funds, it is reasonable to anticipate a positive relationship between an upward-sloping yield curve and net interest margins. To the degree that banks experience a positive maturity gap between the average maturities of their assets and the average maturities of their liabilities, revenues from longer-term assets should exceed expenses from shorter-term liabilities under an upward-sloping yield curve condition. This leads to our first hypothesis:

> H_1: There is a direct relationship between the yield curve and bank profitability expressed through its net interest margin. We hypothesize $\beta_3 > 0$ in equation (1) but the response is likely to differ across bank samples.

Research on the determinants of bank profit margins by Angbazo (1997) and Aliaga-Diaz and Olivero (2011), among others, suggests that the cyclical behavior of bank profit margins may be explained through channels other than monetary policy and credit risk. Monetary policy is believed to have a direct effect on net profit margins through the bank lending channel; for example, an increase in the fed funds rate leads to a reduction in lending and increased borrowing costs. These actions in turn force banks to make upward adjustments in their net interest margins to cover the rising costs. If, as expected, higher credit risk is linked to periods of declining economic activity then banks must increase their net interest margins to cover their cost of capital due to the increased risk exposure. In a strong economy credit is readily available, interest rates are manageable, demand for goods and services is generally favorable, which are elements that support profitability for well managed firms, including banks. Albertazzi and Gambacorta (2009) suggest that an improvement in economic conditions increases lending demand by households and firms and improves the financial conditions of borrowers, with positive effects on the profitability of the traditional financial intermediation activities. The second hypothesis is as follows:

> H_2: There is a positive relationship between the real GDP growth rate and bank profitability expressed through its net interest margin. Since real GDP growth rate is a variable contained in *macro*, we hypothesize $\beta_2 > 0$ in equation (1).

4. Results

Table 2 reports results from the panel model specification applied to the small, medium, large, and money center bank samples and for all banks combined for our full sample period. The dependent variable in all models is the one period change in the net interest margin scaled by average bank earning assets.

We will discuss the results for all banks first (last columns in Tables 2-4) and then move to other class sizes later. Results are statistically significant with both positive and negative coefficients on the real GDP growth variable (the first two lags are positive and the fourth lag is negative and statistically significant), with positive net effect (sum of 1.240 across the four quarters) of real GDP growth on net interest margins. Thus a 0.1% increase in the quarterly real GDP growth rate favorably impacts the change in net interest margins by 0.124%. Evaluating this coefficient at the mean of 0.005 (translates to 0.5% in percent terms) quarterly GDP growth reported in Table 1, Panel F.1, the overall impact on the change in net interest margins is **0.0062 or 0.62%**, positive but not very large. Our finding differs from Aliaga-Diaz and Olivero (2011), who report a negative (yet statistically insignificant) effect of GDP on net interest margins on their quarterly data on U.S. banks for the period 1979-2005. Bolt et al. (2012) find that real GDP has a significant negative influence on net interest income as a stand-alone regressor that turns positive when interacted with long-term interest rates. Our result is consistent with Albertazzi and Gambacorta (2009) who find a direct relationship between real GDP and net interest margins (RGDP coefficient of 0.648) in their study of annual aggregate bank data from 1981 to 2003 for 10 industrialized countries including the U.S.

For the yield curve, results are also statistically significant for the first three lags (the first is negative and the other two are positive and statistically significant), with positive net effect of 0.037 across quarters of changes in yield curve on net interest margins. Therefore, the change in net interest margins grows by 3.70% given a 1% increase in the slope of the yield curve. Evaluating this coefficient at the mean of 1.972 of yield curve reported in Table 1, Panel F.1, the overall impact is **0.0730 or 7.30%,** positive and larger than the RGDP effect. Bolt et al. (2012) report a positive net effect of 0.110 across quarters (only first lag being significant) on the impact of the yield curve on net interest margins based individual bank data. For inflation, results are statistically significant with both positive and negative coefficients (the first lag is positive and statistically significant and the other three lags are negative), with negative net effect (sum of -9.162 across quarters) of inflation on net interest margins. This suggests that a 0.1% increase in the quarterly inflation growth rate negatively impacts the change in net interest margins by -0.916%. At the mean inflation level, the overall impact on NIM is **-0.0183 or -1.83%**, which is higher (in absolute value) than the growth effect but not as high as the impact from the yield curve. Bolt et al. (2012) find that inflation has a significant positive effect on net interest income as a stand-alone regressor that turns negative when interacted with short-term interest rates.

Our finding contrasts with Albertazzi and Gambacorta (2009), who report a statistically insignificant effect of inflation on net interest margins. Similarly, Aliaga-Diaz and Olivero (2011) find that inflation has no impact on net interest margins in their study. Overall, our results suggests that the positive impact of yield curve on NIM outweighs the negative impact of inflation and the positive impact of economic growth over the whole sample.

Under an alternative specification, we incorporate a financial crisis dummy variable to our benchmark model (enters the model with one lag) to assess the impact of the 2007-2009 financial crisis on net interest margins. As expected, we find a negative and statistically significant impact of the crisis on net interest margins e.g. coefficients of -0.057, -0.059, -0.087,-0.061, and -0.054 for small, medium, large, money center, and all banks, respectively.[10] This result aligns with Figure 2 that shows sharply reduced net interest margins for each bank size during the financial crisis period compared to non-crisis periods. The above coefficients, which measure the average difference in net interest margins between the 2007-2009 financial crisis and non-crisis periods, suggest that during the financial crisis, net interest margins were lower by roughly 5-6 basis points for the small, medium, and money center banks and close to 9 basis points for large banks. Our findings nicely complement Egly and Mollick (2013) who conclude that the U.S. Treasury capital purchase program's (CPP) objective to boost loan growth and business activity during the crisis remained unfulfilled .

The subsamples provide a nice complement to the main hypothesis in this paper. According to Table 3 for the first subsample, real GDP growth variable has negative net effects (sum of -0.826 across quarters) on net interest margins which translates to an unfavorable impact of -0.026% on the change in net interest margins per every 0.1% increase in real GDP growth. Assessing this coefficient at the mean of 0.004 quarterly GDP growth (see Table 1, Panel F.2), the overall impact is **-0.0033 or -0.33%** which contrasts with our positive effect recorded in the full sample. This negative result is in instep with Aliaga-Diaz and Olivero (2011), who show that

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[10] For brevity, in the narrative we only report the crisis dummy variable coefficients; the alternative estimations (and related diagnostics) that include the 2007-2009 financial crisis variable are not reported in table form in this study but are available from the authors upon request.

bank profit margins are consistently countercyclical even when controlling for the effects of credit risk and monetary policy.   For the yield curve, there is a positive net effect of 0.026 across quarters, which evaluated at the mean of 1.679 reported in Table 1, Panel F.2, leads to the overall impact is **0.0437 or 4.37%**, positive and larger than RGDP effects. As for inflation, the negative net effect (sum of -14.269 across quarters) evaluated at the mean of 0.002 reported in Table 1, Panel F.2, implies an overall impact of **-0.0285 or -2.85%**, negative on NIM, which is again higher (in absolute value) than the effect of economic growth but not as high as the positive impact from the yield curve.

According to Table 4 for the second subsample, real GDP growth variable has now positive net effects (sum of 3.608 across quarters) on net interest margins which implies a favorable impact of 0.361% on the change in net interest margins per every 0.1% increase in real GDP growth. Based on the mean coefficient of 0.006 quarterly GDP growth reported in Table 1, Panel F.3, the overall impact becomes **0.0216 or 2.16%.** The positive impact of real GDP on net interest margins supports the view of Albertazzi and Gambacorta (2009) as described in the data analysis section of the paper. For the yield curve, there is a positive net effect of 0.034 across quarters, which evaluated at the mean of 2.388 of yield curve reported in Table 1, Panel F.3, the overall impact turns out to be an impressive **0.0812 or 8.12%**, positive and more than three times larger than the combined effect of RGDP. As for inflation, there is now a positive net effect (sum of 4.901 across quarters), which evaluated at the mean of 0.001 reported in Table 1, Panel F.3 implies an overall impact of **0.0049 or 0.49%**, smaller than the largest effect due to the yield curve and the positive impact on NIM due to RGDP growth since the 2007-2009 crisis.

We are using the deposit/loan ratio as the main variable from the bank asset-liability composition. As discussed in the data section on Table 1, Panels E.1 to E.3, the D/L ratio increased from mean of 47.94% to 61.38%, which reflects the aftermath of the recession and approval of more government regulation on banks. Making an exercise similar to the macro factors above, the magnitudes of the effects of deposits/loan - evaluated at sample means – changes across periods. It is negative overall: **-0.0028 or -0.28%** for the whole sample (sum of -0.005 evaluated at mean of 0.554), varying from **-0.0077 or -0.77%** for the first subsample (sum of -0.016 evaluated at mean of 0.4794) to a positive **0.0411 or 4.11%** for the second subsample (sum of 0.067 evaluated at mean of 0.6138), which suggests an effect not only larger in magnitude of D/L on NIM more recently, but also changing signs. In the first subsample an increase in D/L leads to lower profits, all else constant, which is consistent with lower lending implying lower profits, the basic principle of banking. In the second subsample, the effect of D/L operates in reverse. To illustrate, in the second subsample, a 1% increase in the D/L ratio would have a ceteris paribus positive impact of 6.7% on the change in net interest margins. Bolt et al. (2012) find that D/L ratio has a significant positive effect on net interest income as a stand-alone regressor that turns negative when interacted with short-term interest rates.

For the whole sample in Table 2, the negative (overall) impact of real GDP growth on net interest margins reported in money center bank samples is in step with the Aliaga-Diaz and Olivero (2011), who discuss the cyclical nature of price-cost margins. They suggest that monetary policy and credit risk are key determinants of the cyclicality of margins with credit risk having a countercyclical effect (credit is more expensive in bad times and cheaper in good times). The positive effects of real GDP growth on net interest margins reported in the small, medium, and large bank samples supports the previously discussed view of Albertazzi and

Gambacorta (2009).[11] For small banks, the overall impact of the yield curve on net interest margins is positive yet modest with positive coefficients in three of the four lags with values of 0.005 and 0.032 with a single negative coefficient of -0.008 reported in the first lag. The overall impact remains positive in the remaining bank samples. This finding support hypothesis one and is consistent with the practical view that bank managers who emphasize lending are more profitable under an upward-sloping yield curve scenario than under a flat or downward-sloping yield curve setting.

Results show a negative impact of inflation on net interest margins for small banks based on negative and statistically significant coefficients of -1.550, -5.946, and -4.390 in lags two through four with a positive and statistically significant coefficient of 7.455 reported in lag one. The overall impact of inflation on net interest remains negative for medium banks, turns positive in the large sample, and has no impact on the money center bank sample. It is possible that the overall negative impact depicted in the small and medium bank samples captures the loss of purchasing power of interest income and loan repayments given rising prices for goods and services. Conversely, the positive effect of inflation on net interest margins reported in the large bank sample implies that large banks are better able to manage inflation expectations by

[11] The relatively large T (T equals 68 quarters) in our bank profitability model applied to our money center and large bank samples (14 and 34 banks, respectively), suggests that estimations may align with time series modeling for these macro-type samples (i.e. T>>N). The population of U.S. commercial banks for our two sub-samples is limited and thus we focus on T growing larger when considering asymptotic properties of the estimators we employ. To avoid spurious regression results and to test for time series dynamics, we apply the Fisher-type panel data unit root tests to our bank variables (panel unit root test results are available upon request). The null of the test is that all panels contain unit roots; our results support stationary in panel series. We also check for (and do not find) serial correlation in the error term based on earlier random and fixed effects estimations that allowed for an AR(1) disturbance process. Other published papers that model bank profitability using random/fixed effects estimation applied to macro-type samples include: Albertazzi and Gambacorta (2009) and Bolt et al. (2012).

adjusting their pricing in order to build revenues to mitigate rising costs. The overall effect of deposits-to-loans on net interest margins is positive, yet small in the small bank sample case, based on negative coefficients ranging from -0.004 in lag 4 to -0.164 in lag 1 offset by a positive coefficient of 0.190 in lag 2. The effect remains positive (yet very small) in the medium bank sample, turns negative in the large bank sample, and is insignificant in the money center sample case. This negative impact supports the idea that purchases of large volumes of liquid, readily-marketable securities (in response to weak loan demand) tend to lower the average yield from a bank's earning assets and reduce its profitability.

In contrast to Bolt et al. (2012), our results show a direct effect of inflation on net interest margins operating through the deposits-to-loans ratio of small, medium, and large banks as evidenced by the positive and statistically significant coefficients of the interaction term. Results suggest that as liquidity risk rises and banks respond by building cash holdings, they are able to "pass on" added liquidity costs through net interest margin adjustments in the small, medium, and large bank sample cases. We find a statistically significant inverse effect consistent with Bolt et al. (2012) only in the money center bank sample case.

Table 3 displays the panel model specification applied to the small, medium, large, and money center bank samples and for all banks combined for the first sample period, while Table 4 reflects results for the recovery period. It is interesting that small, medium, money center, and all banks show opposite effects with regards to the impact of real GDP growth on net interest margins when compared to the full sample case during the initial sample period. In the recovery period, with the exception of money center and large banks, there is a large net positive effect of real GDP growth on net interest margins. In sum, real GDP growth exerts a mixed impact on bank net interest margins, seems sensitive to the time period under review, and its effect varies based on bank asset size. The influence of the yield curve on net interest margins remains positive in the initial sample period (with no effect for large banks) and stays positive in the recovery period for all bank sizes except for the money center banks. We conclude that the impact of the yield curve on net interest margins is greater (based on the magnitude of the coefficients) for small, medium, and all banks combined in our recovery period estimations when compared to our initial period sample estimations.

The effect of inflation on net interest margins reported in the initial period in Table 3 resembles what is found in the full sample period with the exception of the large bank/(money center) sample in which no effect is found in the initial/(full) sample. The effect becomes positive across all bank samples in the recovery period as shown in Table 4 and is consistent with the idea that banks successfully manage inflation expectations with the exception of the non-impact for money center banks. Table 3 shows that the impact of deposits-to-loans on net interest margins remains negative and small in the initial period for medium and large banks with no effect detected for money center banks with the effect remaining positive yet negligible for the small banks. In the recovery period an opposite effect is evident for medium, large, and all banks when compared to the initial period and no impact of deposits-to-loans on net interest margins for the money center banks. With respect to the interaction between deposits-to-loans and inflation, results from the initial period reported in Table 3 display a similar pattern to those reported in the full sample period while the effects from the medium and large banks dissipate and the small and all bank effects turns negative in the recovery period in Table 4.[12]

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[12] In earlier stages of our research, we had explored alternative bank profitability models incorporating other potentially important variables including for example: bank assets, net charge offs, liquidity, interest rate risk-exposure, and Tier 1 risk-based capital as suggested in the banking literature (e.g., Angbazo (1997), Albertazzi and Gambacorta (2009), Aliaga-Diaz and Olivero (2011), and Bolt et al (2012)). In our initial model estimations (with no lags), the R squares were low ranging from 0.009 for the medium bank sample to 0.025 for the small bank

5. **Concluding Remarks**

The 2007-2009 financial crisis created havoc in the banking industry as evidenced by substantial losses, significant market capital erosion, and major write-downs in lending portfolios. Throughout the crisis, bank lending dampened (in part due to the exposure in their real estate portfolios) while bank liquidity was rebuilt. The effects of the 2007-2009 financial crisis have diminished and bank profitability has been restored.

Panel data methods are applied to a very large sample of U.S. banks categorized on asset size that comprises 4,981 small banks, 475 medium banks, 34 large banks, and 14 money-center banks to examine the sensitivity of bank profitability to fluctuations in the yield curve. Recent research on bank profitability has either omitted the yield curve, such as Aliaga-Diaz and Olivero (2011), or has used it in panel of countries together with long-term rates, such as Bolt et al. (2012), or even used the short-term interest rate in combination with volatility as in Arnold and van Ewijk (2012) for bank margins in Euro area countries. In an environment where short-term rates became very close to zero after 2008, long-term rates and the yield curve almost coincide (as shown in Figure 1 in this paper) and a modification of the empirical model is implemented to better estimate the effects of yield curve (along with RGDP growth, inflation, and D/L ratios) on bank profits (NIM). The near zero short-term interest rates exhibited in the U.S. after 2008 led Apergis and Christou (2015) to examine bank lending channel (BLC) behavior over a sample

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sample over the full sample period. With the aim of introducing a parsimonious model, we choose to follow Bolt et al. (2012) while focusing on the U.S. banking system and employing quarterly data. The R squares on Bolt's et al. (2012) net interest income estimations based on multiple countries and annual data range between 0.197 and 0.296. It is noted that on their ROA estimations, the reported R squares range from 0.018 to 0.029 which are in line with our reported results. The behavior of our random sample is plausibly triggering this statistical issue on model fit. The low-R squares indicate that it is difficult to predict individual outcomes on bank profitability with any accuracy; low R squares, however, are not uncommon, particularly when estimating bank behavior. The zero conditional mean assumption ($E(u \mid x1, x2,...,xk) = 0$ is what determines whether we obtain unbiased estimators of the ceteris paribus effects of the independent variables and the size of the R square has no direct bearing on this (refer to Wooldridge (2003)) period from 2000 to 2012 for a number of Eurozone commercial banks covering 8 countries. Employing instrumental quantile regression methods to a forward-looking Taylor rule and controlling for bank-specific characteristics, they show that the presence of the BLC was confirmed at the mean of the estimations yet the results are substantially weaker at low-order interest quartiles towards zero lower bound.

We conclude in this paper that in the full sample period the yield curve has a positive impact on net interest margins that persists in the small and medium banks. The most likely explanation is that the yield curve contains important information about the real economy. Kurmann and Otrok (2013), for example, estimate vector auto regressions for the U.S. economy from 1959 to 2005 and conclude that the main driver of fluctuations in the slope of the term structure is news about future TFP (total factor productivity), which as a measure of productivity growth adds information to past real GDP growth. We also determine in this paper that the impact increases in the recovery period for all bank sizes except for the money center sample. During the recovery period, our sample banks recorded aggregate average annual net interest incomes of U.S. $42.8 billion, U.S. $65.2 billion, U.S. $60.9 billion, and U.S. $194.4 billion for small, medium, large, and money center banks, respectively. Employing the yield curve's mean impact of 0.0812 on net margins (while holding all other factors constant) implies a favorable boost to bank profits of U.S. $3.5 billion, U.S. $5.3 billion, U.S. $4.9 billion, and U.S. $15.8 billion, respectively. Our results suggest net interest margins have stabilized for small and medium banks, are on the decline for large and money-center banks in the post-crisis period, and, except for medium banks, have not been restored to pre-crisis levels.

The findings in our paper have important implications. First, the trends in net interest margins suggest that banks will need to remain increasingly focused on their asset liability management practices and develop innovative strategies to retain (and build) fee based revenue sources. Second, the reduced cash flows driven by downward pressure on net interest margins forces banks to retain profits and payout fewer dividends when Tier 1 capital buffers are below required levels. Third, regulators must be cognizant of banks' plausible shifts in profit seeking behavior over time that could be linked to swings in the yield curve. While the impact seems to vary based on bank size, we have documented the role of the yield curve in bank profitability using a very large and comprehensive sample of U.S. banks. During the 2007-2009 financial crisis period, we see that the magnitude of net interest margin erosion, while modest, is not consistent across bank size with large banks experiencing the greatest decline; this behavior implies a reassessment of pre-established safety and soundness regulatory guidelines. With increasing credit risk, uncertainty in banks' balance sheet values, net margin erosion, and government intervention, banks' have focused on liquidity building in the post crisis period.

The following questions remain for further research: Will we witness a loosening of bank credit standards to promote bank lending (and by extension, bank profitability) to help revive the economy? What about bank exposure to exogenous shocks such as foreign exchange and oil risks and their impact on bank profits? How will an eventual subsequent contraction of the Federal Reserve's balance sheet, which should hypothetically have a negative impact on liquidity in the financial system, impact bank profitability? These questions are at the forefront of ongoing research on banks and the economy.

< Insert Tables 1 – 4 about here >

REFERENCES

Acharya, Viral, Lasse Padersen., Thomas Philipon and Matthew Richardson (2010). "Measuring Systemic Risk." Working Paper, New York University Stern School of Business

Adrian, Tobias and Hyun S. Sung. (2010). "Liquidity and Leverage." *Journal of Financial Intermediation,* Vol. 19, 418-437.

Albertazzi,Ugo and Leonardo Gambacorta. (2009). "Bank Profitability and the Business Cycle." *Journal of Financial Stability*, Vol. 5, 393-409.

Aliaga-Diaz, Roger and Maria Pia Olivero. (2011). "The Cyclicality of Price- Cost Margins in Banking: An Empirical Analysis of its Determinants." *Economic Inquiry,* Vol.49, 26-46

Angbazo, Lazarus. (1997). "Commercial Bank Net Interest Margins, Default Risk, and Off-Balance Sheet Banking" *Journal of Banking and Finance,* Vol. 21, 55-87.

Apergis, Nicholas and Arusha Cooray (2015). "Asymmetric Interest Rate Pass-Through in the U.S., the U.K. and Australia: New Evidence from Selected Individual Banks." *Journal of Macroeconomics,* Vol. 45, 155-172.

Apergis, Nicholas and Christina Christou (2015). "The behaviour of the bank lending channel when interest rates approach the zero lower bound: Evidence from quantile regressions." Economic Modelling, Vol 49, 296-307.

Arnold, Ivo and Saskia van Ewijk. (2012). "The Quest for Growth: The Impact of Bank Strategy on Interest Margins." *International Review of Financial Analysis*, Vol. 25, 18-27.

Bolt,W., De Haan, L., Hoeberichts, M., Van Oordt, M., and Swank, J., (2012). "Bank Profitability During Recesssion." *Journal of Banking and Finance,* Vol. 36, 2552-2564.

Cecchetti, S. (2009). "Crisis and Responses: The Federal Reserve in the Early Stages of the Financial Crisis." *Journal of Economic Perspectives,* Vol. 23, 51-75.

Cornett, M., McNutt J., Strahan, P.,and Tehranian, H., (2011). "Liquidity Risk Management and Credit Supply in the Financial Crisis." *Journal of Financial Economics,* Vol.101, 297-312.

Egan, Mark, Ali Hortaçsu, and Gregor Matvos. (2017). "Deposit Competition and Financial Fragility: Evidence from the U.S. Banking Sector." *American Economic Review,* Vol.107 (1), 169-216.

Egly, Peter and André Mollick. (2013). "Did the U.S. Treasury's Capital Purchase Program (CPP) Help Bank Lending and Business Activity?" *Review of Quantitative Finance and Accounting,* Vol. 40, 747-775.

Ensign, R. L. (2016). "A Radical New Idea: Banks as Growth Stocks." *The Wall Street Journal*, November 16, 2016.

Greene, William. (2003). Econometric Analysis, Fifth edition, Pearson Education, New Jersey

He, Zhiguo, In Gu Khang and Arvind Krishnamurthy. (2010). "Balance Sheet Adjustments in the 2008 Crisis." NBER Working Paper 15919, Cambridge, MA.

Hausman, J. (1978). "Specification Tests in Econometrics." *Econometrica*, Vol. 46, 1251-1271.

Huang, Wanling, Mollick, André V., and Khoa H. Nguyen. (2016). "U.S. Stock Markets and the Role of Real Interest Rates." *Quarterly Review of Economics and Finance*, Vol. 59, 231-242.

Kosak, Marko, Shaofang Li, Igor Loncarski, and Matej Marinc. (2015). "Quality of Bank Capital and Bank Lending Behavior during the Global Financial Crisis." *International Review of Financial Analysis*, Vol. 37, 168-183.

Kurmann, André and Christopher Otrok. (2013). "News Shocks and the Slope of the Term

Structure of Interest Rates." *American Economic Review,* Vol.103 (6), 2612-2632.
Loutskina, Elena. (2011). "The Role of Securitization in Bank Liquidity and Funding Management." *Journal of Financial Economics,* Vol. 100,663-684.
Peristian,Stavros, Donald Morgan and Vanesa Savino. (2010). "The Information Value of the Stress Test and Bank Opacity." Working Paper, Federal Reserve Bank of New York
Shleifer, A. and Vishny, R. (2010). "Unstable Banking." *Journal of Financial Economics,* Vol.97, 306-318.
Stiroh, Kevin. (2004). "Diversification in Banking: Is Noninterest Income the Answer?" *Journal of Money Credit and Banking,* Vol. 35, 853-882.
Subrahmanyam, Vijaya, Anita Pennathur and Deborah Smith. (2011). "The Differential Impact of Financial Regulation on Financial Institutions over 2007-2009." Working Paper, Mercer University.
Taylor, John B. (2016). "The Case for a Rules-Based Fed." *The Wall Street Journal*, December 21, 2016.
Taylor, John and John Williams. (2009). "A Black Swan in the Money Market." *American Economic Journal,* Vol.1, 58-83.
Verma, Priti and Dave Jackson. (2008). "Interest Rate and Bank Stock Return Asymmetry: Evidence from U.S. Banks." *Journal of Economics and Finance*, Vol.32, 105-118.
Veronesi, Pietro and Luigi Zingales. (2010). "Paulson's Gift." *Journal of Financial Economics*, Vol.97, 339-368.
Wooldridge, Jeffrey. (2003). Introductory Econometrics, Second Edition, Thomson South-Western, Ohio

Table 1 Descriptive Statistics - Panels A and B

Panel A.1 Small Bank Subsample (Total Assets < U.S. $1 billion)

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Net Interest Margin	315043	3.947	1.040	-2.260	72.640
Assets	315043	224644	274391	207	17100000
Loans	315043	146246	187298	0	13100000
Deposits	315043	117180	134785	0	9000408

Panel A.2 Small Bank Subsample (Total Assets < U.S. $1 billion), subsample 2000Q1 through 2009Q2

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Net Interest Margin	184407	4.084	1.126	-2.260	72.640
Assets	184407	181340	164384	982	1565124
Loans	184407	120805	118601	0	1414196
Deposits	184407	89091	77131	0	1010823

Panel A.3 Small Bank Subsample (Total Assets < U.S. $1 billion), subsample 2009Q3 through 2016Q4

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Net Interest Margin	130636	3.754	0.871	-0.270	25.260
Assets	130636	285772	370194	207	17100000
Loans	130636	182159	250083	0	13100000
Deposits	130636	156831	180908	0	9000408

Panel B.1 Medium Bank Subsample (Total Assets ≥ U.S. $1 billion and < U.S. $20 billion)

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Net Interest Margin	29461	3.820	1.727	-3.570	34.770
Assets	29461	3451094	4547638	14217	71800000
Loans	29461	2276399	3087703	0	57100000
Deposits	29461	1414525	1926864	0	36900000

Panel B.2 Medium Bank Subsample (Total Assets ≥ U.S. $1 billion and < U.S. $20 billion) subsample 2000Q1 through 2009Q2

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Net Interest Margin	17896	3.938	1.610	-0.050	30.940
Assets	17896	2555866	2995899	14217	23700000
Loans	17896	1707787	2097256	645	22300000
Deposits	17896	960948	1208440	0	15200000

Panel B.3 Medium Bank Subsample (Total Assets ≥ U.S. $1 billion and < U.S. $20 billion) subsample 2009Q3 through 2016Q4

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Net Interest Margin	11565	3.637	1.879	-3.570	34.770
Assets	11565	4836395	5969709	19046	71800000
Loans	11565	3156284	4025799	0	57100000
Deposits	11565	2116403	2527393	0	36900000

See the footnotes at end of table 1 which is continued on the next three pages

Table 1 Descriptive Statistics – continued - Panels C and D

Panel C.1 Large Bank Subsample (Total Assets ≥ U.S. $20 billion and < U.S. $90 billion)

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Net Interest Margin	2073	3.387	1.772	0.090	14.870
Assets	2073	50000000	40300000	393588	286000000
Loans	2073	29200000	23300000	5518	157000000
Deposits	2073	17500000	19000000	0	137000000

Panel C.2 Large Bank Subsample (Total Assets ≥ U.S. $20 billion and < U.S. $90 billion) subsample 2000Q1 through 2009Q2

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Net Interest Margin	1229	3.502	1.754	0.090	13.160
Assets	1229	33100000	20000000	393588	118000000
Loans	1229	20100000	13000000	5518	67600000
Deposits	1229	9695763	8293462	0	51900000

Panel C.3 Large Bank Subsample (Total Assets ≥ U.S. $20 billion and < U.S. $90 billion) subsample 2009Q3 through 2016Q4

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Net Interest Margin	844	3.220	1.786	0.090	14.870
Assets	844	74600000	48800000	14500000	286000000
Loans	844	42500000	28200000	3550942	157000000
Deposits	844	28900000	23900000	167000	137000000

Panel D.1 Money-center Bank Subsample (Total Assets ≥ U.S. $90 billion)

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Net Interest Margin	895	3.247	0.852	0.000	5.700
Assets	895	438000000	513000000	32500000	2120000000
Loans	895	217000000	228000000	20200000	934000000
Deposits	895	99200000	125000000	227000	582000000

Panel D.2 Money-center Bank Subsample (Total Assets ≥ U.S. $90 billion) subsample 2000Q1 through 2009Q2

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Net Interest Margin	532	3.454	0.792	0.000	5.700
Assets	532	302000000	351000000	32500000	1770000000
Loans	532	161000000	162000000	20200000	728000000
Deposits	532	61300000	65500000	227000	352000000

Panel D.3 Money-center Bank Subsample (Total Assets ≥ U.S. $90 billion) subsample 2009Q3 through 2016Q4

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Net Interest Margin	363	2.944	0.846	0.900	4.870
Assets	363	637000000	635000000	84000000	2120000000
Loans	363	298000000	281000000	22400000	934000000
Deposits	363	155000000	165000000	816000	582000000

See the footnotes at end of table 1 which is continued on the next two pages

Table 1 – Descriptive Statistics - continued - Panel E

Panel E.1 All Banks

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Net Interest Margin	347472	3.931	1.122	-3.570	72.640
Assets	347472	1921746	34600000	207	2120000000
Loans	347472	1057591	16200000	0	934000000
Deposits	347472	586059	8347592	0	582000000

Panel E.2 All Banks Subsample 2000Q1 through 2009Q2

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Net Interest Margin	204064	4.066	1.182	-2.260	72.640
Assets	204064	1374160	23800000	982	1770000000
Loans	204064	798866	11800000	0	728000000
Deposits	204064	382937	4692617	0	352000000

Panel E.3 All Banks Subsample 2009Q3 through 2016Q4

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Net Interest Margin	143408	3.740	1.000	-3.570	34.770
Assets	143408	2700939	45700000	207	2120000000
Loans	143408	1425746	21000000	0	934000000
Deposits	143408	875095	11700000	0	582000000

See the footnotes at end of table 1 which is continued on the next page

Table 1 – Descriptive Statistics - continued - Panel F

Panel F.1 Macro-economic variables

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Long Term Interest	68	3.668	1.215	1.563	6.480
Short Term Interest	68	1.697	1.909	0.013	6.017
Yield Curve	68	1.972	1.118	-0.450	3.610
Real GDP Growth	68	0.005	0.006	-0.021	0.019
Inflation	68	0.002	0.003	-0.013	0.008

Panel F.2 Macro-economic variables Subsample 2000Q1 through 2009Q2

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Long Term Interest	38	4.495	0.757	2.737	6.480
Short Term Interest	38	2.817	1.777	0.173	6.017
Yield Curve	38	1.679	1.273	-0.450	3.523
Real GDP Growth	38	0.004	0.007	-0.021	0.019
Inflation	38	0.002	0.004	-0.013	0.008

Panel F.3 Macro-economic variables 2009Q3 through 2016Q4

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Long Term Interest	30	2.491	0.634	1.563	3.717
Short Term Interest	30	0.103	0.092	0.013	0.430
Yield Curve	30	2.388	0.651	1.267	3.610
Real GDP Growth	30	0.006	0.004	-0.005	0.012
Inflation	30	0.001	0.002	-0.005	0.006

Notes Panels A through F: The bank variables assets, loans and deposits, are expressed in levels and in thousands of dollars. The net interest margin is the total interest income less total interest expense (annualized) as a percent of average earning assets. The loan variable includes total loans and leases net of unearned income and allowance. The deposit variable consists of FDIC insured deposits. The sample covers from 2000Q1 to 2016Q4. The bank data was downloaded from Federal Deposit Insurance Corporation (FDICs) statistics on depository institutions (SDI) database: http://www2.fdic.gov/sdi/index.asp. The SDI information is extracted from quarterly call reports (FFIEC form FFIEC-031 for banks with domestic and foreign offices or form FFIEC-041 for banks with domestic offices only). The yield curve is defined as the difference between our long term interest rate measured through the 10-year U.S. Treasury Bond Constant Maturity rate (series GS10) and our short term interest rate captured by the 3-month U.S. Treasury Bill rate (series TB3MS) which are in monthly frequency and then averaged to quarterly frequency. The real GDP growth rate variable is defined as the quarterly growth rate (calculated from the GDPC1 series - US Real Gross Domestic Product, Billions of Chained 2009 Dollars, Quarterly, Seasonally Adjusted). The inflation variable is calculated as the quarterly average monthly percent change in the Consumer Price Index for All Urban Consumers: All Items, Index 1982-1984=100, Monthly, Not Seasonally Adjusted. The macro variables were downloaded from the Federal Reserve Bank of Saint Louis website http://research.stlouisfed.org/fred2 last accessed on 05/14/2017.

Table 2 Panel models by bank size. Dependent variable: net interest margin

	Small Banks	Medium Banks	Large Banks	Money Center Banks	All Banks
Real GDP growth t-1	0.731*** / (0.122)	2.195*** / (0.412)	5.754*** / (1.926)	-3.480* / (2.035)	1.237*** / (0.110)
Real GDP growth t-2	0.430*** / (0.110)	-0.311 / (0.433)	-1.465 / (2.007)	-5.586*** / (2.114)	0.329*** / (0.088)
Real GDP growth t-3	-0.314*** / (0.113)	-0.383 / (0.421)	0.372 / (1.962)	3.728* / (2.051)	-0.075 / (0.075)
Real GDP growth t-4	-0.581*** / (0.198)	-1.731*** / (0.412)	-4.490** / (1.934)	0.185 / (2.119)	-0.326*** / (0.109)
Yield curve t-1	-0.008*** / (0.002)	-0.001 / (0.005)	0.030 / (0.026)	0.074*** / (0.026)	-0.007*** / (0.001)
Yield curve t-2	0.032*** / (0.002)	0.019*** / (0.005)	0.044* / (0.026)	-0.045* / (0.027)	0.031*** / (0.002)
Yield curve t-3	0.006** / (0.002)	0.023*** / (0.005)	0.053** / (0.026)	0.018 / (0.027)	0.013*** / (0.002)
Yield curve t-4	0.005*** / (0.001)	-0.013** / (0.005)	-0.035 / (0.025)	-0.034 / (0.026)	0.001 / (0.001)
Inflation t-1	7.455*** / (0.514)	7.968*** / (1.522)	10.336** / (4.776)	12.022 / (9.350)	4.621*** / (0.446)
Inflation t-2	-1.550*** / (0.395)	-3.207** / (1.630)	-7.148 / (5.614)	11.108 / (9.415)	-3.515*** / (0.333)
Inflation t-3	-5.946*** / (0.422)	-5.076*** / (1.658)	-1.897 / (5.581)	11.708 / (9.467)	-6.639*** / (0.422)
Inflation t-4	-4.390*** / (0.333)	-5.832*** / (1.660)	-3.049 / (5.139)	1.823 / (9.684)	-3.629*** / (0.203)
Deposits t-1/Loans t-1*Inflation t-1	-0.732 / (0.528)	-0.818 / (2.085)	-4.501 / (5.627)	-61.142*** / (20.578)	2.436*** / (0.484)
Deposits t-2/Loans t-2*Inflation t-2	-0.502 / (0.625)	2.962 / (2.276)	5.873 / (7.608)	-42.098** / (20.548)	2.259*** / (0.366)
Deposits t-3/Loans t-3*Inflation t-3	3.425*** / (0.420)	5.213** / (2.332)	3.242 / (7.720)	-22.209 / (20.715)	3.997*** / (0.476)
Deposits t-4/Loans t-4*Inflation t-4	0.130 / (0.095)	6.169*** / (2.295)	12.404* / (6.460)	-27.598 / (21.066)	0.109 / (0.086)
Deposits t-1/Loans t-1	-0.164** / (0.072)	-0.001 / (0.001)	0.023** / (0.011)	0.012 / (0.355)	-0.002 / (0.002)
Deposits t-2/Loans t-2	0.190*** / (0.069)	-0.005 / (0.006)	-0.002 / (0.013)	0.676 / (0.487)	0.006** / (0.003)
Deposits t-3/Loans t-3	-0.005*** / (0.001)	-0.122*** / (0.027)	-0.025* / (0.013)	-0.114 / (0.469)	-0.007*** / (0.001)
Deposits t-4/Loans t-4	-0.004*** / (0.000)	0.128*** / (0.028)	-0.009 / (0.009)	-0.303 / (0.333)	-0.004*** / (0.000)
Constant	-0.022*** / (0.006)	-0.017* / (0.009)	-0.015 / (0.026)	-0.059 / (0.053)	-0.006*** / (0.001)
Bank specific effects - F statistic	0.390	0.400	0.380	0.070	0.390
Probability > F	1.000	1.000	0.999	1.000	1.000
Durbin Watson d statistic	1.919	2.203	2.288	2.682	1.961
Probability > Std Normal *N* (0,1)	0.738	0.403	0.234	0.005	0.872
Hausman Test-Chi square	231.690	23.890	1.270	0.230	132.940
Prob > Chi-square	0.000	0.200	1.000	1.000	0.000
Breusch Pagan Test Statistic	0.000	0.000	0.000	0.000	0.000
Prob > Chi-square	1.000	1.000	1.000	1.000	1.000
Pooled OLS/Fixed/Random Effects[a]	fixed	random	random	random	fixed
R^2 within; between; overall	0.0235; 0.0068; 0.0227	0.0136; 0.0621; 0.0137	0.0296; 0.0193; 0.0295	0.0765; 0.0632; 0.0764	0.0175; 0.0129; 0.0174

[a] selected model based on test results

Table 2 notes: Sample period 2000Q1-2016Q4. The dependent variable net interest margin consists of the difference between total interest income and total interest expense scaled by bank average earning assets. The bank deposits-to-loans variable is expressed in ratio form. We apply an F test to assess bank specific effects; null hypothesis common intercept α for all banks (i.e. no bank specific effects). We run a Durbin Watson (DW) test to check for serial correlation in error terms; DW d statistic values close to 2 suggest non-serially correlated errors; null hypothesis of zero first-order autocorrelation; asymptotically, d statistic follows a standard normal distribution. We employ Hausman tests to determine whether fixed or random effects are the appropriate specification. The statistic is Chi-square distributed; the null hypothesis is that coefficients estimated by random effects estimator are the same as the ones estimated by the fixed effects estimator. We implement a Breusch Pagan (BP) test on our random effects model based on OLS residuals; null hypothesis is that variance across banks is zero. Standard errors are reported in parenthesis. The symbols *, **, *** refer to the levels of significance of 10%, 5% and 1%, respectively. There are 4,981 small banks, 475 medium banks, 34 large banks, and 14 money center banks as of the beginning of the sample period. There are 290,124, 27,075, 1,903, and 825 observations, respectively. The "All Banks" column contains 5,504 banks and 319,927 observations.

Table 3 Panel models by bank size. Dependent variable: net interest margin, subsample 2000Q1 through 2009Q2

	Small Banks	Medium Banks	Large Banks	Money Center Banks	All Banks
Real GDP growth t-1	0.791*** / (0.149)	1.773*** / (0.501)	6.342** / (2.813)	-3.100 / (3.350)	1.083*** / (0.155)
Real GDP growth t-2	0.135 / (0.151)	-0.978* / (0.570)	-2.920 / (3.194)	-4.837 / (3.802)	-0.002 / (0.145)
Real GDP growth t-3	-1.687*** / (0.149)	-1.258* / (0.673)	2.381 / (3.811)	9.785** / (4.493)	-1.451*** / (0.147)
Real GDP growth t-4	-0.395** / (0.170)	-0.470 / (0.633)	-2.088 / (3.591)	-2.477 / (4.187)	-0.458*** / (0.164)
Yield curve t-1	-0.003 / (0.002)	0.003 / (0.006)	0.046 / (0.035)	0.098** / (0.041)	-0.002 / (0.002)
Yield curve t-2	0.016*** / (0.002)	0.015** / (0.007)	0.053 / (0.041)	-0.040 / (0.047)	0.015*** / (0.002)
Yield curve t-3	-0.005* / (0.003)	0.025*** / (0.007)	0.017 / (0.038)	-0.020 / (0.044)	0.000 / (0.002)
Yield curve t-4	0.014*** / (0.001)	-0.009 / (0.006)	0.015 / (0.035)	-0.053 / (0.040)	0.011*** / (0.001)
Inflation t-1	8.387*** / (0.753)	2.058 / (1.845)	7.303 / (6.324)	34.638** / (15.510)	6.917*** / (0.742)
Inflation t-2	-0.778* / (0.457)	-6.203*** / (1.883)	-7.772 / (7.721)	18.956 / (15.304)	-2.684*** / (0.476)
Inflation t-3	-12.539*** / (0.669)	-13.629*** / (2.393)	-9.310 / (9.086)	34.607 / (22.287)	-11.850*** / (0.670)
Inflation t-4	-6.993*** / (0.405)	-14.634*** / (2.476)	-7.960 / (8.840)	25.869 / (23.205)	-6.652*** / (0.397)
Deposits t-1/Loans t-1*Inflation t-1	-5.487*** / (0.883)	7.209*** / (2.744)	-5.883 / (7.049)	-140.514*** / (36.234)	-3.472*** / (0.861)
Deposits t-2/Loans t-2*Inflation t-2	-2.105*** / (0.567)	9.215*** / (2.771)	11.026 / (10.634)	-79.713** / (35.496)	1.219** / (0.612)
Deposits t-3/Loans t-3*Inflation t-3	7.778*** / (0.707)	14.435*** / (3.388)	13.036 / (12.200)	-94.810* / (52.235)	6.952*** / (0.712)
Deposits t-4/Loans t-4*Inflation t-4	0.123 / (0.095)	17.293*** / (3.326)	21.621** / (8.963)	-96.532* / (52.780)	0.135 / (0.108)
Deposits t-1/Loans t-1	-0.338*** / (0.027)	0.030 / (0.037)	0.021 / (0.014)	0.293 / (0.623)	-0.015 / (0.035)
Deposits t-2/Loans t-2	0.359*** / (0.027)	-0.341*** / (0.052)	-0.011 / (0.018)	1.136 / (0.889)	0.025 / (0.033)
Deposits t-3/Loans t-3	-0.009*** / (0.001)	0.203*** / (0.051)	-0.041** / (0.017)	-0.456 / (0.889)	-0.010*** / (0.001)
Deposits t-4/Loans t-4	-0.006*** / (0.000)	0.014 / (0.038)	-0.019 / (0.012)	0.001 / (0.664)	-0.006*** / (0.000)
Constant	0.016*** / (0.006)	0.050*** / (0.016)	-0.016 / (0.060)	-0.293* / (0.150)	0.023*** / (0.005)
Bank specific effects - F statistic	0.390	0.310	0.170	0.070	0.380
Probability > F	1.000	1.000	1.000	1.000	1.000
Durbin Watson d statistic	1.810	2.144	2.325	2.756	1.847
Probability > Std Normal N (0,1)	0.434	0.553	0.180	0.002	0.527
Hausman Test-Chi square	55.170	0.780	0.780	0.900	57.820
Prob > Chi-square	0.000	1.000	1.000	1.000	0.000
Breusch Pagan Test Statistic	0.000	0.000	0.000	0.000	0.000
Prob > Chi-square	1.000	1.000	1.000	1.000	1.000
Pooled OLS/Fixed/Random Effects[a]	fixed	random	random	random	fixed
R^2 within; between; overall	0.0274; 0.1098; 0.0279	0.0218; 0.0748; 0.0223	0.0353; 0.1180; 0.0355	0.1244; 0.0757; 0.1239	0.0190; 0.0696; 0.0192

[a] selected model based on test results

For extended notes refer to Table 2. Sample period 2000Q1-2009Q2. There are 4,981 small banks, 475 medium banks, 34 large banks, and 14 money center banks as of the beginning of the sample period. There are 159,497, 15,521, 1,059, and 462 observations, respectively. The "All Banks" column contains 5,504 banks and 176,539 observations.

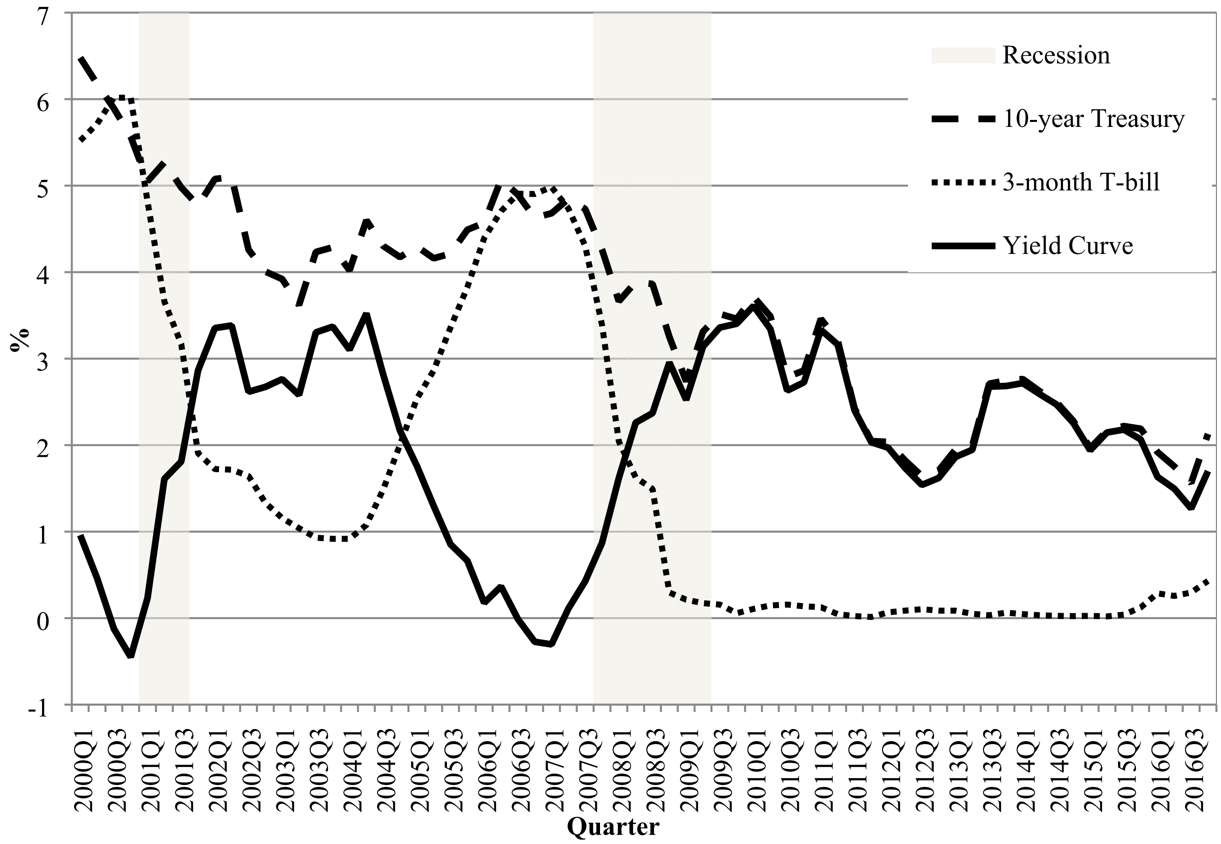
Table 4 Panel models by bank size. Dependent variable: net interest margin, subsample 2009Q3 through 2016Q4

	Small Banks	Medium Banks	Large Banks	Money Center Banks	All Banks
Real GDP growth t-1	3.545*** / (0.266)	5.726*** / (1.548)	6.638* / (3.326)	2.072 / (1.801)	3.937*** / (0.216)
Real GDP growth t-2	1.962*** / (0.171)	2.143*** / (0.743)	1.273 / (2.203)	-0.425 / (2.369)	1.947*** / (0.169)
Real GDP growth t-3	0.175 / (0.118)	-0.202 / (0.535)	-1.248 / (1.500)	-1.570 / (1.041)	0.138 / (0.118)
Real GDP growth t-4	-2.268*** / (0.256)	-5.376** / (2.304)	-6.407** / (2.962)	-2.094 / (1.814)	-2.276*** / (0.240)
Yield curve t-1	-0.028*** / (0.003)	-0.009 / (0.009)	-0.011 / (0.013)	-0.036** / (0.014)	-0.025*** / (0.002)
Yield curve t-2	0.048*** / (0.003)	0.017 / (0.016)	0.034 / (0.021)	0.018 / (0.025)	0.043*** / (0.003)
Yield curve t-3	0.030*** / (0.004)	0.051*** / (0.015)	0.081** / (0.035)	0.024 / (0.017)	0.036*** / (0.002)
Yield curve t-4	-0.016*** / (0.003)	-0.024 / (0.016)	-0.102 / (0.068)	-0.032 / (0.026)	-0.020*** / (0.002)
Inflation t-1	14.157*** / (0.851)	11.648*** / (4.331)	15.252** / (6.449)	14.336 / (9.463)	13.120*** / (0.908)
Inflation t-2	-1.712** / (0.706)	-6.125** / (2.921)	-0.223 / (5.380)	15.925 / (19.790)	-2.525*** / (0.699)
Inflation t-3	-3.207*** / (0.574)	-7.227 / (7.869)	6.051 / (8.058)	8.289 / (8.300)	-3.644*** / (0.635)
Inflation t-4	-2.377*** / (0.547)	-4.351* / (2.395)	7.169 / (9.142)	1.117 / (5.689)	-2.050*** / (0.554)
Deposits t-1/Loans t-1*Inflation t-1	-0.059 / (0.738)	4.077 / (7.315)	2.353 / (8.624)	-15.042 / (19.761)	0.671 / (0.857)
Deposits t-2/Loans t-2*Inflation t-2	-2.013*** / (0.688)	4.414 / (3.365)	-4.757 / (3.795)	-44.073 / (35.112)	-0.879 / (0.688)
Deposits t-3/Loans t-3*Inflation t-3	-2.036*** / (0.459)	4.480 / (9.905)	-6.233 / (9.114)	-20.764 / (13.997)	-1.798*** / (0.588)
Deposits t-4/Loans t-4*Inflation t-4	-2.746*** / (0.473)	2.592 / (3.522)	-5.195 / (8.690)	-20.148* / (9.950)	-2.722*** / (0.514)
Deposits t-1/Loans t-1	-0.095 / (0.063)	-0.001*** / (0.000)	-0.099 / (0.238)	-0.496 / (0.587)	-0.002* / (0.001)
Deposits t-2/Loans t-2	0.078 / (0.054)	0.008 / (0.019)	0.561* / (0.289)	0.470 / (0.430)	-0.001 / (0.002)
Deposits t-3/Loans t-3	0.087*** / (0.014)	-0.158** / (0.064)	-0.647 / (0.396)	0.375 / (0.337)	0.069*** / (0.017)
Deposits t-4/Loans t-4	-0.024** / (0.012)	0.327** / (0.161)	0.263 / (0.217)	-0.134 / (0.190)	-0.004 / (0.017)
Constant	-0.072*** / (0.011)	-0.163* / (0.092)	-0.087* / (0.050)	-0.113 / (0.110)	-0.090*** / (0.010)
Bank specific effects - F statistic	0.680	0.590	1.360	1.610	0.380
Probability > F	1.000	1.000	0.094	0.079	1.000
Durbin Watson d statistic	2.125	2.250	2.181	1.650	2.144
Probability > Std Normal N (0,1)	0.605	0.302	0.456	0.149	0.552
Hausman Test-Chi square	183.800	48.460	37.680	393.900	321.470
Prob > Chi-square	0.000	0.000	0.000	0.000	0.000
Breusch Pagan Test Statistic	0.000	0.000	0.000	0.000	0.000
Prob > Chi-square	1.000	1.000	1.000	1.000	1.000
Pooled OLS/Fixed/Random Effects[a]	fixed	fixed	fixed	fixed	fixed
R^2 within; between; overall	0.0342; 0.0054; 0.0275	0.0180; 0.0022; 0.0069	0.0641; 0.0016; 0.0556	0.1262; 0.0316; 0.1094	0.0269; 0.0089; 0.0172

[a] selected model based on test results

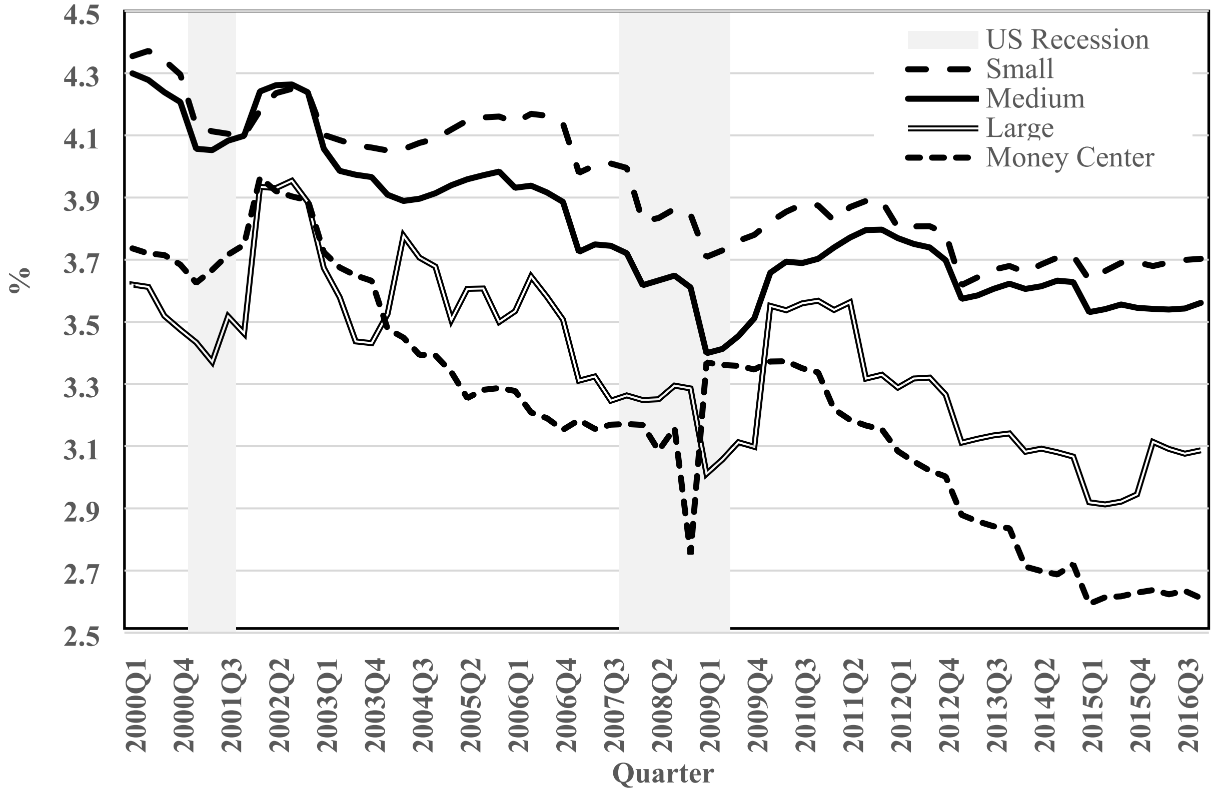
For extended notes refer to Table 2. Sample period 2009Q3-2016Q4. There are 4,956 small banks, 467 medium banks, 31 large banks, and 14 money center banks as of the beginning of the sample period. There are 130,627, 11,554, 844, and 363 observations, respectively. The “All Banks” column contains 5,468 banks and 143,388 observations

Figure 1 Yield Curve with Long-term and Short-term rates



The yield curve is defined as the difference between the 10-year U.S. Treasury Bond Constant Maturity rate (series GS10) and the 3-month U.S. Treasury Bill rate (series TB3MS) which are in monthly frequency downloadable from the Federal Reserve Bank of Saint Louis: http://research.stlouisfed.org/fred2 (data retrieved on 5/14/2/2017), then averaged to quarterly frequency. The U.S. recessionary periods are quarterly frequency (USRECQ) per NBER downloaded from http:// research.stlouisfed.org/fred2 (data retrieved on 5/14/2017).

Figure 2 Net Interest Margin by Bank Size



Net Interest Margin (NIM) is defined as the difference between total interest income and total interest expense which is divided by average earning assets. The variables are measured in quarterly frequency and downloaded from FDICs SDIs website http://www2.fdic.gov/sdi/index.asp. US recessionary periods are quarterly frequency (USRECQ) per NBER downloaded from http:// research.stlouisfed.org/fred2 (data retrieved on 5/14/2017).