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THE DRIVERS OF US BANKS' DEMAND OF GOVERNMENT SECURITIES

by Carlos Alberto Piscarreta Pinto Ferreira[1]

KEYWORDS

Sovereign Debt, Portfolio Choice, Banks, Monetary Policy, Panel data.

JEL CODES

C23, E58, G11, G21, H63

ABSTRACT

We use individual bank balance sheet data to investigate those bank-specific characteristics that are relevant to explain US banks' demand of two groups of government securities: Agencies and Treasuries. We conclude that some drivers but not all are common. Higher holdings are associated with poorer loan portfolio quality in both cases. Agencies also respond positively to lower margins, a contracting economic cycle, sub-par regional dynamics and less clearly higher business cycle risk. Treasuries alone are positively impacted by the erosion of the capital position. Variables such as the loan rate spread, past profitability, or income diversification fail to be significant. We find no direct impact of unconventional monetary policy in Agencies and the impact on Treasuries seems time-bounded and bank entity specific. Our finding suggest that it will be mainly up to other investors than banks to replace the Fed as it reduces its balance sheet.

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1. Introduction

The aim of this paper is to provide empirical insights on the drivers of banks' demand of government securities in the US.

Our analysis is based on the micro foundations of banks' asset allocation decisions and hence closely related with the strand of empirical literature focusing on the bank-specific characteristics determinants of sovereign bond holdings such as the work of Rodrigues (1993), Ogawa & Imai (2014), Buch et al. (2016) and Affinito et al. (2022).

Banks are an important investor in the sovereign debt market. In advanced economies they hold 25% of non-official holdings and 16% of total holdings at the end of 2023, according with the June 2024 update of the Sovereign Debt Investor Base (Arslanalp & Tsuda, 2014). In the US value are somewhat lower, 17% and 12%, respectively.

But how relevant are government bonds for banks portfolios? The data collected by the IMF in the Monetary and Financial Statistics does not distinguish government bonds from other claims on the central government. Over the period 2001-21, gross claims on the central government have an average weight on bank total assets of 4.5% in the US. More recent values for the US tend to be higher than the average (10.7%).

As disruptions in supply-chains, demand and supply imbalances, and higher commodity prices, namely energy, propelled inflation for levels not seen for decades since mid-2021, domestic central banks stopped government debt net purchases. The Fed ended purchases in March 2022 and announced in May the details of a plan for reducing the size of its balance sheet starting on 1 June 2022. The phase-in of the reduction in reinvestments started with a monthly value of $30 billion in Treasuries and $17.5 billion in Agencies mortgage-backed-securities (MBS), values to be stepped-up to the double of these monthly figures at cruise speed from September on. According with that plan, the Fed's $8.5 trillion portfolio should be halved by 2027Q2. On May 1, 2024, the Fed announced plans to slow the speed of its balance sheet drawdown to ensure this process does not create undue stress in financial markets. Starting on June 1 it reduced the cap on Treasury securities it allows to mature and not be replaced to $25 billion from its current cap of up to $60 billion per month, leaving unchanged the $35 billion per month cap on MBS.

This change in sovereign bond market dynamics raises the question of which type of investors will replace central banks. Can we expect domestic banks in their normal line of business to step in? To answer this question, we need to understand what drives bank asset portfolio decisions.

This paper contributes to the literature by updating previous research on the determinants of government securities bank demand in the US market, by investigating the possible impact of large-scale asset transactions conducted by the Fed and testing the empirical significance of precautionary motives to hold safe assets linked to business cycle risks and uncertainty regarding the loan and deposit market.

We follow previous literature and treat separately two groups of government securities: Agencies and Treasuries. Our analysis of a sample of 114 US banks over 20 years suggests that higher Agencies holdings are associated with poorer loan portfolio quality, lower price cost margins, booming national and regional economies and less clearly business cycle risk. Treasuries respond positively to poorer loan portfolio quality and financial leverage (debt-to-equity). We find no direct impact of unconventional monetary policy in Agencies and the impact on Treasuries seems time-bounded and bank entity specific. Our finding suggest that it will be mainly up to other investors than banks to replace the Fed as it reduces its balance sheet.

The remainder of this paper is structured as follows. Section 2 reviews the relevant literature. In Section 3 we introduce the base portfolio allocation model. Section 4 presents the data and offers some descriptive statistics. Section 5 details the empirical strategy and the result for Agencies and Treasuries. The main findings and policy take-aways are summed-up in Section 6.

2. Literature Review

In the theoretical literature bank holdings of sovereign bonds are linked to liquidity management, as a buffer asset between loans and deposits, to funding management, as collateral for interbank loans, to portfolio diversification and to bank capital, in its role of cushion against unexpected risks as the riskless asset. A more detailed revision of this literature can be found in Ferreira (2023).

Agencies bonds provide basically the same functions but being less liquid than Treasuries will tend to be less effective in what regards liquidity and specially funding management.

In the empirical literature higher holdings are usually associated with weaker capital positions, worse loan performance, greater importance of collateralized liabilities, and larger pool of liquid assets. On the other hand, the relationship is negative regarding the loan rate spread. The association with profitability, efficiency or the share of fees in the income revenue is less clear as results for Japan, Italy and Germany point in opposite directions. Risk precautionary effects on sovereign bond demand are typically missing.

In the empirical literature concerning the US, Krishnamurthy & Vissing-Jorgensen (2007) attribute banks' US government bond demand to short-term liquidity needs and to the effect of regulatory capital requirements that favour "the liquidity/low risk of Treasury securities over other assets". They estimate a demand price -semi-elasticity close to one, a value between the more inelastic demand of governmental groups and the more elastic demand of households and long-term investors. In the authors' view banks' relative position validates the liquidity motive as their fundamental driver of demand. The fact that banks' holdings dropped from an impressive 42% of total Treasury securities in 1945 to 3% in 2005, as well as the use of time trends in their regressions, indicates the possible presence of other structural drivers. In fact, Neuberger (1993) point out that bank portfolios have changed substantially along the years as banks replaced securities first by business loans and particularly after the 1980s by mortgage loans.

Different researchers investigated US commercial banks' securities demand out of concern with the impact that a surge in holdings could have on the transmission of monetary policy and the recovery after the economic through in March 1991. Typically banks purchase safer government securities during recessions and early economic recovery while waiting for more attractive loan opportunities to re-emerge. In this instance, commercial banks instead build-up the portfolio of securities, including US government securities, although part of that growth was driven by an already in motion trend for higher holding of mortgage-backed securities issued or guaranteed by US agencies.

Regulatory changes following the credit crunch of the 1980s (an overview can be found in Wall & Peterson, 1996) affected developments in the early 90s, namely the phase-in of the risk-based capital standards agreed in 1988 (Basle I). Regarding this, Furfine (2000) argues that the effects observed in 1989-92 in fact reflect the increase of both risk-based and non-risk based (leverage ratio) capital requirements. Shrieves & Dahl (1995) computations of mean target capital ratios in 1985-89 and 1990-91 confirm higher capital targets in the second period. Furthermore, it seems that regulators used stricter criteria to evaluate the quality of bank loans in the early 1990s than they had in the 1980s, effectively raising even more the required minimum capital-to-asset ratio (Bizer, 1983).

Rodrigues (1993) combines time-series and cross-section analysis. Using quarterly data between 1979 Q1 – 1989 Q4, he regresses the change in the ratio of government securities' holdings to total banks' assets on current and lagged output growth (demand factor), several lags of the spread of the effective loan rate over 5-year Treasuries (lending margin factor), and the fourth lag of the dependent variable to account for seasonality in the data. His results point to weak demand and low lending margins - due to the unusual steep interest rates term structure - as partial explanatory factors of banks' securities build-up. However, model forecasts over 1990-92 underestimate government securities' increase, suggesting other factors have an important role in explaining the observed change. The cross-section partial adjustment model over 10,042 banks focus on the role of bank loan quality and capital requirements as possible drivers of bank securities holdings in the 1990-92 period. It assumes banks have an unobserved target portfolio share for government securities that relates with bank features, namely loan performance (measured as loan loss provisions to loans), bank size, asset growth over 1990-92 (taken as a proxy for extraordinary lending opportunities) and dummy variables describing bank capital position appraisal at the beginning of 1990 which rated each institution in three categories: well-capitalized, adequately capitalized, and undercapitalized. Separate models are estimated for Treasuries and Agency securities. Positive changes in Treasuries' share are driven by higher loan loss provisions-to-loans. The change is lower for well and adequately capitalized banks in comparison with undercapitalized ones. Positive changes in Agency securities are also driven by worse loan quality being lower just for well capitalized banks. A negative parameter for the level of assets point to a smaller response from larger banks. Haubrich & Wachtel (1993) regress changes in the ratio of government securities to total assets with loan performance proxied by net charge-offs and dummies for size and different capital classes and reaches similar conclusions: poorly capitalized banks make larger portfolio adjustment from credit to government securities[2]. Hancock et al. (1995) use impulse response functions for securities of a 9 variables VARX to show that a positive response to a negative capital shock prevails for 3 quarters before partially reverting. The response is larger and has a different pattern than the one observed in the 1980s (1986 Q1 – 1989 Q3). Response from banks with capital shortfalls is larger and persists positive for one more quarter, probably because they rely more in the re-composition of assets in favour of less capital-intensive alternatives since raising capital is usually more expensive for smaller banks. Thus, it seems that stiffer capital requirements did lead undercapitalized banks to increase their securities holdings beyond the amounts implied by their loan performance vis-à-vis their peers. Berger & Udell (1993) dissent. They test the relation of growth rates of bank asset categories with five variables reflecting banks' assessment of their risk position including risk-based measures of capital (RBMC). Their findings suggest that the RBMC credit crunch hypothesis fares the worst of all the alternative explanations of the bank credit reallocation of the 1990s. They also find that the effects of the RBMC ratios on lending did not get consistently stronger in the early 1990s, and that the RBMC ratios generally acted to counteract each other in their effect on credit allocation. However, the other credit crunch theories examined even if somewhat more consistent with the data, do not show substantial quantitative effects.

Keeton (1994) starts by confirming the unusual size of banks' security holdings once adjusted for inflation and long-term economic growth by taking its ratio to potential GDP. The proposed explanation for this development includes temporary and permanent factors. Temporary factors include the slowdown in economic activity, the unprecedent fact that the Fed continued to ease after the recession ended which possibly rose deposits demand faster than loan demand, and a temporary decline in loan demand and supply, as overborrowing in the 80s made firms and households reluctant to borrow and heavy losses in the late 80s and regulators pressure to avoid risk made banks more risk-averse (Bernanke & Lown (1992); Cantor & Wenninger (1993); Johnson (1991)). Permanent explanations are twofold: the impact of risk-based capital standards and a more pessimistic view on long-term prospects for bank lending.

[2] Asset size has a curious impact. Furlong (1992) using panel data in the period 1985-91 finds that large banks loan growth has a greater sensitivity to the capital position (previous period capital to target capital) and that smaller banks (less than $1 billion in assets) credit change only started reacting to the capital position in the 1990-91 period. These results suggest that capital regulation had effectively shifted for small banks, on the one hand, and that capital regulation tends to be in general more binding for larger banks, on the other hand. As previous authors had found, a substantial proportion of the slower loan growth is not accounted for by changes in the capital position or by changes in capital regulation.

Keeton (1994) uses regression analysis to estimate how much of the increase can be attributed to the three temporary factors cited above. All the empirical results are based on a vector autoregression (VAR) estimated with quarterly data over the 1960-89 period on four lags of three macro variables (the federal funds rate, the ratio of actual GDP to potential GDP, and the GDP deflator) and four bank balance sheet variables (securities, loans, core deposits and large time deposits measured as a ratio to potential GDP). Variance decomposition for 1960-89 show that shocks to the three macroeconomic variables and loans account for 80% of the variation on ratio of securities to potential GDP. The decomposition of unexpected changes in the securities ratio between 1989-93 leave a significant proportion to shocks to securities rather than to the different explanatory variables, namely after 1992, one year into the economic recovery. This leads the author to conclude that, save eventual structural breaks in the variables' relationships, the unexplained increase in the security ratio could reflect a permanent shift in bank portfolio preferences from loans to securities.

A further review of the empirical literature covering non-US markets may be found in Ferreira (2023).

3. The Portfolio Allocation Model

Our empirical analysis departs from a log-linear model used by Ogawa & Imai (2014) which is itself an adaptation of the classical Monti-Klein model of an oligopolistic banking system. The portfolio allocation model assumes:

- (i) Banks make allocation decisions regarding the amounts to lend and to invest in government bonds.
- (ii) Each bank faces a downward sloping loan demand curve.
- (iii) The lending production technology is linearly homogeneous thus unit lending costs do not depend on the quantity of loans.
- (iv) The government bond market is perfectly competitive hence government bond yields are a given for each bank.
- (v) Banks maximize profits in respect of their asset allocation subject to a total assets' constraint and minimum capital adequacy requirements regarding lending.
- (vi) Debt and equity finance total assets and are assumed to be predetermined in regard the asset allocation decision.
- (vii) The unobserved lending margin is proxied by a relation comprising the margin (defined as the ratio of interest on loans to interest and general expenses), total assets and quality measures of the loan portfolio).

The demand for government bonds is given by:

$$(1)\ \text{LOG}\, G_{it} = \alpha + \beta_0 \,\text{LOG}\, A_{it} + \beta_1 \,\text{LOG}\, \frac{R^L_{it}}{R^G_{it}} + \beta_2 \,\text{LOG}\, MG_{it} + \beta_3 \,\text{LOG}\, NPL_{it} + \beta_4 \,\text{LOG}\, LEV_{it} + \beta_5 \,\text{LOG}\, \frac{Y_t}{Y^P_t} + \beta_6 \,\text{LOG}\, \frac{Y^R_t / Y^R_{t-1}}{Y_t / Y_{t-1}} + \vartheta_{it} \ \ , i = 1, \dots, N; t = 1, \dots, T,$$

where i and t denotes each bank and time period, respectively, G_{it} represents bank holdings of government bonds, $\frac{R^L_{it}}{R^G_{it}}$ stands for the relation between the bank loan rate and government bond yields, MG_{it} is the price-cost margin, an efficiency measure, defined as the relation between loans interest revenues and the sum of interest and general administrative expenses, NPL_{it} is the ratio of non-performing loans to total loans, a measure of credit quality, LEV_{it} is a non-risk based measure of leverage, A_{it} represent bank assets, $\frac{Y_t}{Y^P_t}$ is the relation between output and potential output, a measure of the cyclical position of the economy, $\frac{Y^R_t / Y^R_{t-1}}{Y_t / Y_{t-1}}$ indicates the relation between regional and national real output growth rates, ϑ_{it} is the random disturbance term.

We experiment with different alternatives to the above-mentioned variables and expand the empirical model by adding some new variables. We explore the impact of unconventional monetary policy by adding the ratio of assets with the central bank to total assets, both over the total sample period and in interaction with a dummy for the period of active Fed transactions. The role of past profitability and income diversification is tested with representative variables best detailed in the next section.

Another set of additional variables aims at capturing the impact of relative asset growth and relative capital position. We use dummies for extreme quartiles affecting the intercept.

A last group of variables is introduced to test empirically the impact of risk suggested by the theory and proved relevant in the case of Japan (Ferreira 2023). The rationale is that precautionary motives would lead to higher allocation to safe assets to safeguard against shocks on output, loan-to-assets, and deposit-to-assets.

4. DATA AND DESCRIPTIVE STATISTICS

4.1 Data Description

Our base US dataset covers 119 banks, mostly commercial banks, over the period 2002-21. Table I shows banks by entity type. About 40% of the banks have a federal charter approved by the Office of the Comptroller of the Currency. State Banks are evenly divided between members and non-members of the Federal Reserve System. Banks' data are sourced directly from the National Information Center of the Federal Financial Institutions Examination Council (FFIEC) or from regulatory filings available on Bank Focus. Aggregate information for all commercial banks assets is from the Board of Governors of the Federal Reserve System of the US. Other main sources are Bloomberg for information regarding 10-year Treasury Bond yields; the US Federal Reserve for data on 30-year fixed rate mortgage annual averages, and the US output gap; the US Bureau of Economic Analysis for data on State level GDP and the World Bank - World Development Indicators for Puerto Rico.

TABLE I – US BANKS BY ENTITY TYPE

	National Banks	State Banks		Savings Banks		Total
		Member	Non-Member	Federal	State	
Number	41	33	36	6	3	119
%	34%	28%	30%	5%	3%	

Source: Federal Financial Institutions Examination Council (FFIEC) – National Information Center

Changes in the banking industry during the sample period pose a challenge. The lack of available past information for entities no longer active, the high number and frequency of mergers and other assets movements make impracticable the use of an adjustment method based on retaining only the data pre-merger or -acquisition for those institutions for which individual data is no longer available after those operations and discard the pre-operation information for those banks under which the post-merger or -acquisition data is reported, as in Ferreira (2023), for Japan. Visual inspection suggests most of the impact takes place in the date of the event. Therefore, we define 75 bank-time-specific dummies that take value 1 in the event-date and 0 in all other dates, to account for banking industry changes.

Our data on government related debt comprises four main categories of securities: (i) US Treasuries; (ii) securities issued by states and political subdivisions in the US; (iii) US Government agency and sponsored agency obligations excluding MBS; (iv) residential mortgage pass-through securities issued or guaranteed by US government agencies or sponsored agencies and other residential MBS either issued or guaranteed by US government agencies or sponsored agencies or collateralized by MBS issued or guaranteed by US government agencies or sponsored agencies.

We will group separately securities holdings of federal government, states, and political subdivisions in the US (henceforth designated as Extended Treasuries) and all US Government agency and sponsored agency obligations (henceforth designated as Agencies) since the underlying trends of the two different categories are different (see Figure 1 and Figure 2), and because zero-holdings of US Treasuries represent about one third of all observations.

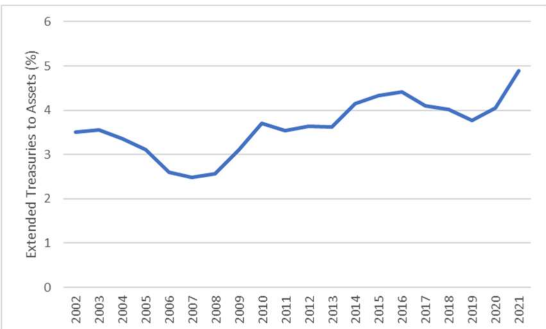

FIGURE 1 – EXTENDED TREASURIES

Source: FFIEC. Author's calculations.

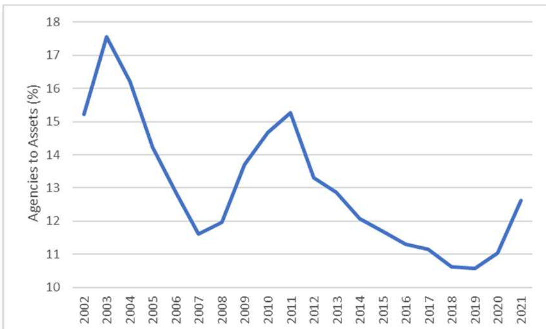

FIGURE 2 - AGENCIES

Source: FFIEC. Author's calculations.

In this paper we start by focusing on Agencies considering its general prevalence in bank's portfolios, then we will investigate Extended Treasuries which exhibit the same trend as US Treasuries (see Figure A 1 and Figure A 2) but have much less zero-holdings.

The loan rate is calculated as the ratio of Interest income on loans to average gross customer loans & advances.

The margin is computed as the ratio of the sum of total interest and fee income on loans and income from lease financing receivables to the sum of total interest expense and total noninterest expense.

Loan quality is assessed using different variables: (i) the NPL ratio is the ratio of the sum of total loans and leases past due 90 days or more and still accruing and nonaccrual loans and leases to loans and leases held for investment and for sale gross of allowance for losses; (ii) the broad NPL ratio has a similar definition but in the numerator are also present total loans and leases past due 30 through 89 days and still accruing and the debt restructurings that are in compliance with their modified terms; (iii) the write-offs ratio is the ratio of charge-offs net of recoveries to loans and leases held for investment and for sale gross of allowance for losses; (iv) the allowance for loan losses ratio is the ratio of allowance for loan and lease losses to loans and leases held for investment and for sale gross of allowance for losses.

Leverage is primarily computed as the ratio of total liabilities to total equity capital. Other alternative leverage indicators are the ratio of total equity capital to total assets, the regulatory leverage ratio, Tier 1 capital ratio and total capital ratio.

The output gap is the ratio of real Gross Domestic Product to real potential Gross Domestic Product. The relation of regional to nationwide output growth rates is the ratio of the respective ratios of current and previous period real Gross Domestic Product.

The return on assets is computed as the ratio of net income (loss) attributable to the bank to total bank assets.

As a proxy of excess reserves at the Federal Reserve we use the ratio of balances due from Federal Reserve Banks to total assets. A dummy variable captures the periods when the Fed engaged in Quantitative Easing (QE) and is used in interaction with the former to understand the impact of unconventional monetary policy measures. The variable takes value 1 in years 2008, 2010, 2011, 2013, 2014, 2020 and 2021, and 0 in all other years. Another variable is used to capture the initial reduction of the Fed's balance sheet in the years 2018 and 2019, taking value 1 in those years, and 0 otherwise.

For size, asset growth and capital position we compute quartile dummies. Quartiles composition is calculated each year, which allows banks to move quartiles across time and permits the use of this variable in regressions with bank-fixed effects. We use one or two extreme quartiles as standalone variables or in interactions with other variables.

We consider banks face uncertainty regarding the business cycle, the loan market, and the deposit market. The first is assessed using the standard deviation of our output gap variable computed over the four quarters of each year in interaction with assets or a diversification indicator. In the case of the loan and deposit markets, we use as uncertainty measures the standard deviation of loans-to assets (deposit-to-assets) over the banks present in the sample in each year in interaction with each bank mean loan-to-assets ratio (deposit-to-assets ratio). As an indicator of activity diversification, we take the ratio of interest income to total income. Thus, a higher figure will mean a lower degree of diversification.

All variables are used in logs with the sole exception of the uncertainty measures.

4.2 Descriptive Statistics

Total assets of US commercial banks assets grew at an annual average rate of 6.6% between 2000 and 2021. Treasuries and Agencies saw its share on assets increasing over the period as its value expanded at an annual average rate of 8.2%. Loans and leases grew at a slower pace of 5.4%, below the 6% of total bank credit which also includes securities. As Figure 4 shows, the surge in Treasuries and Agencies was particularly strong following the Covid-19 pandemic, even when compared with the increase observed in the aftermath of the GFC.

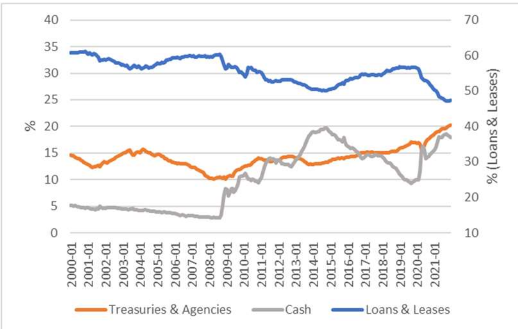

FIGURE 3 – BANK ASSETS (% OF TOTAL)

Source: Board of Governors of the Federal Reserve System of the US. Author's calculations.

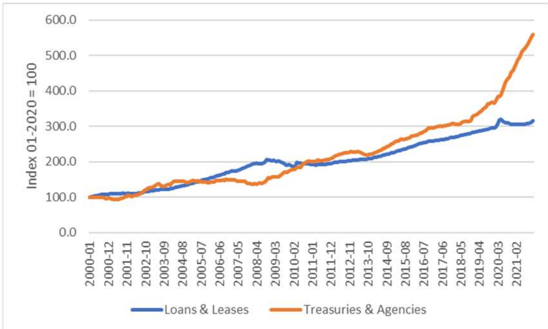

FIGURE 4 – LOANS AND TREASURIES & AGENCIES

Source: Board of Governors of the Federal Reserve System of the US. Author's calculations.

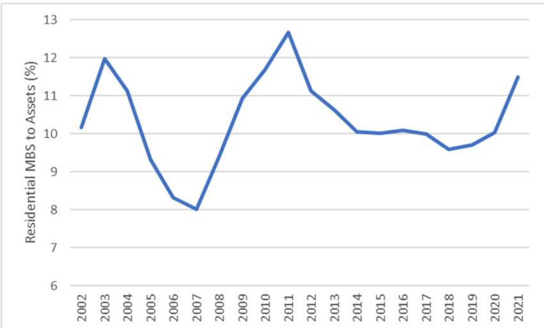

FIGURE 5 – RMBS MEAN HOLDINGS

Source: FFIEC. Author's calculations over sampled 119 banks.

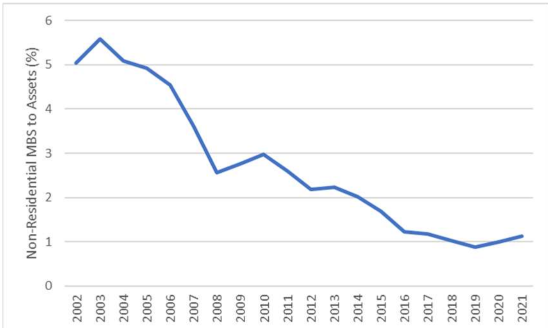

FIGURE 6 – NON-RMBS MEAN HOLDINGS

Source: FFIEC. Author's calculations over sampled 119 banks.

Computation of mean holdings over the 119 banks in our sample shows that although Agencies inched up in 2019 due to an increase in Residential MBS (RMBS), their weight has been decreasing over the years. This trend is entirely driven by the fall in non-RMBS from 5% to 1% of total assets, as RMBS weight has been hovering mainly in the range 10-12%, except for 2006-08 when it fell as low as 8%.

Contrary to what was observed in Japan, Fed's large-scale asset purchases (LSAP) programmes do not appear to have negatively affected in a significant way bank holdings of government securities. However, as remarked by Di Maggio et al. (2016), "most bank proceeds from LSAP remained in excess reserves with the Fed".

In fact, excess reserves seem to have played the role of government securities as an alternative asset for loans & leases after the GFC. Up to the end of 2014 they replaced loans in banks asset portfolios, and from then on until the end of 2019, they shrunk to accommodate loan's expansion. Rolling regressions of changes in Loans and leases on changes in Treasuries & Agencies and Cash Assets over a window of 48 months show the latter clearly statistically significant following the GFC, while the former loose statistical significance during much of the sample period. Regressions over the entire period (see Table A I) show that Treasuries & Agencies are only significant at the 10% level. When we divide the sample in three sub-periods the variable shows no statistical significance during 2008-15. This suggests that variables capturing the alternative role of government securities to loans such as the loan rate spread may be hard to identify statistically.

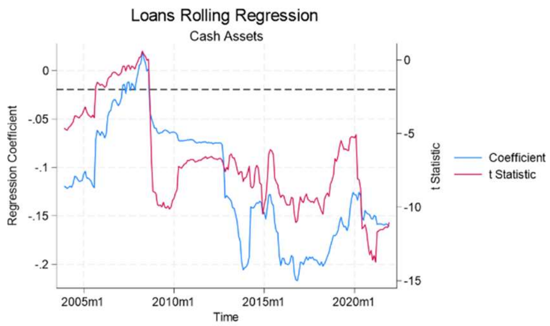

FIGURE 7 – CASH TO ASSETS ROLLING COEFFICIENT AND T STATISTIC
Source: Board of Governors of the Federal Reserve System of the US. Author's calculations.

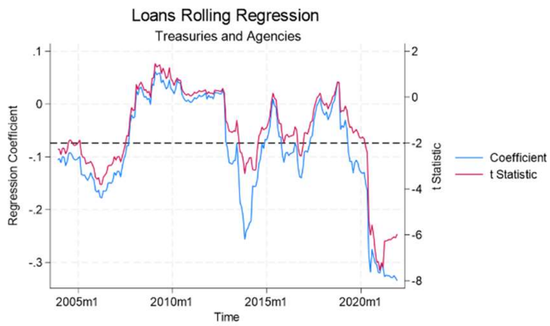

FIGURE 8 – TREASURIES & AGENCIES ROLLING COEFFICIENT AND T STATISTIC
Source: Board of Governors of the Federal Reserve System of the US. Author's calculations.

Bank loan rates, 30-year mortgage rates, and 10-year Treasury yields, all fell during the sample period. The loan rate spread exhibits in both cases a moderate positive trend, suggesting an expansion of Loans and the opposite movement for Treasuries and Agencies. However, this is not in line with the data, providing another clue that the statistical significance of the loan rate spread may be difficult to identify.

In opposition to what we have find for Japan (Ferreira, 2023), the 'risk-taking channel' transmission mechanism of monetary policy (Adrian & Shin, 2009; Borio & Zhu, 2008) appears to have been effective in the US, as the loan-to-assets ratio end up reacting positively to the three LSAP programmes and to the low level of interest rates up to the Covid-19 pandemic shock.

The very mild upward trend in the loan margin observed up to the GFC was followed by a decisive improvement. The positive reaction of bank loans seems to have been mainly absorbed by a decrease of excess reserves, which may constraint the expected negative relation between this variable and holdings of government securities.

Non-performing loans surged during the GFC bearing a positive relation with the simultaneously observed increase in government securities holdings. The subsequent down-trend up to the Covid-19 shock is matched by the downward movement in Agencies holdings but not by Treasuries.

Leverage trends down during the sample period suggesting a positive (negative) relationship with Agencies (Treasuries) holdings.

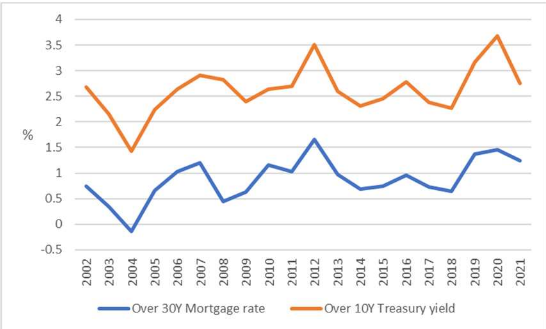

FIGURE 9 – LOAN RATE SPREAD

Source: Bank Focus and Bloomberg. Author's calculations.

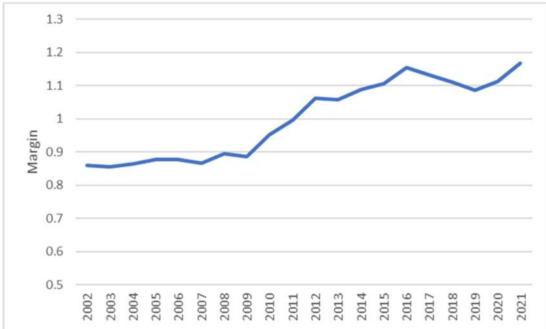

FIGURE 10 – LOAN MARGIN

Source: Bank Focus. Author's calculations.

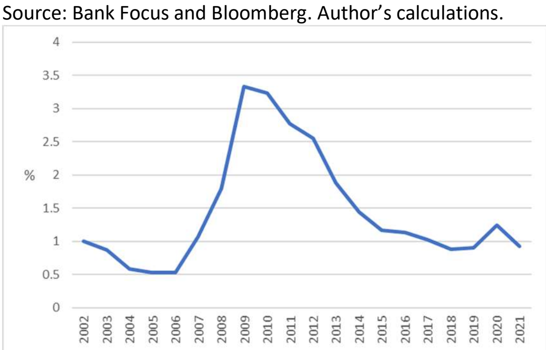

FIGURE 11 – NPL RATIO

Source: Bank Focus. Author's calculations.

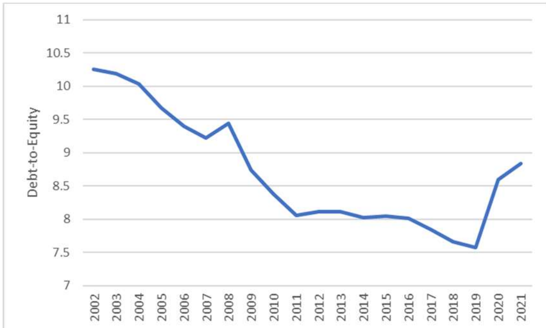

FIGURE 12 – DEBT-TO-EQUITY RATIO

Source: Bank Focus. Author's calculations.

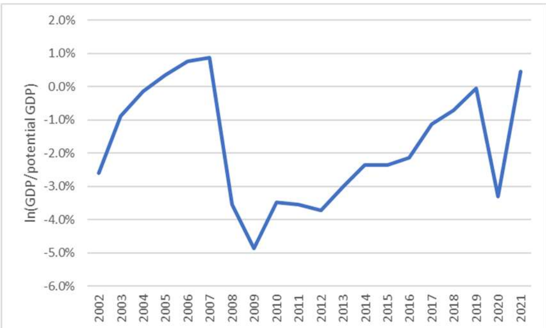

FIGURE 13 – OUTPUT GAP

Source: US Federal Reserve. Author's calculations.

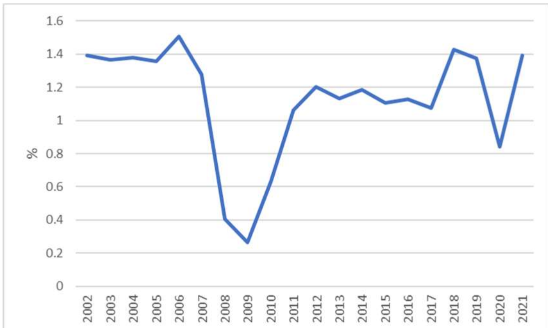

FIGURE 14 – RETURN ON ASSETS

Source: Bank Focus. Author's calculations.

Mean return on assets (ROA) of sampled banks dropped abruptly with the GFC. The observed increase in government securities holdings following the GFC does not match the expectation of past losses driving more risk-taking and less government securities holdings. ROA recovered subsequently, though it has yet failed to return consistently to the levels of the early 2000s. Again, this is not matched by an increase in government securities' holdings, which points to a possible difficult to identify statistically negative relationship between the two variables, differently from what we observed in Japan (Ferreira, 2023). Identification is expected to be particularly hard in the case of Treasuries, as the correlation between the variables is substantially weaker.

Table II shows descriptive statistics for the ratio of Extended Treasuries and Agencies to Total Assets, excluding banks for which we have less than 10 observations. The overall mean of Extended Treasury securities holdings is 3.9% and of Agencies is a higher 13.1%. Treasury securities holdings are more volatile, with a coefficient of variation of 1.24 vs 0.71 of Agencies holdings. Variability across banks and variations over time within each bank are uneven, with variability across institutions predominating in both cases. Mean Treasuries holdings is only 1.5% but increases to 2.2% when zero-holdings are excluded. Variability between banks is smaller, even when we control for zero-holdings.

TABLE II – TREASURIES AND AGENCIES TO BANK ASSETS DESCRIPTIVE STATISTICS

	Treasuries		Ext. Treasuries		Agencies	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Overall	1.51	3.59	3.89	4.81	13.13	9.30
Between		2.28		3.57		7.30
Within		2.81		3.22		5.87
Decomposition SS						
Between		40.5%		56.2%		60.7%
Within		59.5%		43.8%		39.3%
Number of Observations	2050		2050		2201	
Number of Banks	107		107		117	
Mean Number of Years per Bank	19.2		19.2		18.8	

Notes: SS = Sum of squares of deviations regarding the mean. The between standard deviation measures variation of the variable's means across banks and is calculated as the square root of SSDB/(T_i(N-1)) where SSDB = $\sum_{i=1}^{N} T_i\left(\bar{X}_i - \bar{\bar{X}}\right)^2$, T_i is the sample period of each bank i, $\bar{X}_i$ is the bank mean, $\bar{\bar{X}}$ is the total sample mean, and N is the number of banks. The within standard deviation measures variation of the variable in each bank over time and is calculated as the square root of SSDW/(NT_i-N), where SSDW = $\sum_{i=1}^{N}\sum_{t=1}^{T_i}(X_{it} - \bar{X}_i)^2$ and X_{it} is the value of the variable of bank i at time t. Because the computation of the different standard deviations uses distinct degrees of freedom the sum of between and within standard deviations do not add up to total standard deviation. Thus, the decomposition is carried out over the sum of squares of deviations regarding the means Source: Bank Focus. Author's calculations.

Holdings of Extended Treasuries and Agencies in relation to total assets vary according with type and scope of the banking institutions (see Table A II). Extended Treasuries holdings are lower at State Non-Member Banks, Savings Banks and banks specialized in the credit card business (see Table A III and Table A IV). Agencies holdings are higher at State Savings Banks (SSBs) and State Member Banks (SMBs), while being lower among banks specialized in the credit card business (see Table A V and Table A VI). Foreign owned banks have lower holdings of Agencies compared with US owned banks. Although the reverse applies to Extended Treasuries holdings, the difference is not statistically significant.

Correlations among the main explanatory variables (see Table A VII) are always below 0.8 indicating absence of potential multicollinearity problems (Studenmund, 2005;

Kennedy, 2008). Nevertheless, a possible source of concern is the high correlation between the margin and the diversification variable.

The presence of cross-sectional dependence is confirmed by the results of the tests suggested by Pesaran (2004) and Pesaran (2015) in Table A VIII. Consequently, we make use of Driscoll & Kraay (1998) standard errors which are robust to general forms of cross-sectional dependence.

5. EMPIRICAL STRATEGY AND RESULTS

We will examine sequentially the three main categories of government securities holdings. The methodology followed may be summarized in three steps. Firstly, we define the baseline specification and use the within estimator to check for time and bank fixed effects, test alternative definitions of our base model and the introduction of additional variables. Having defined the set of explanatory variables, in a second step we test the possible endogeneity of the loan rate spread and the margin using an Instrumental Variables estimator. Thirdly, and since endogeneity is rejected, we use the system-GMM estimator and other appropriate estimators to correct the bias resulting from the presence of a lagged dependent variable in a model of unobserved fixed effects.

5.1 Agencies

5.1.1 Baseline Specifications

We start by running a pooled OLS regression of the log-linear portfolio allocation model of equation (1) adjusted for possible different means across bank types (card business specialist, foreign owned, SMBs and SSBs) and impact of mergers/acquisitions (75 event dummies) to investigate the possible presence of heteroskedasticity and serial correlation.

The Breusch-Pagan (1979) / Cook-Weisberg (1983) test confirms the presence of heteroskedasticity (see Table A IX). The Levene (1960) and Brown & Forsythe (1974) tests on equality of variances robust to nonnormality rejects the null hypothesis of constant variance across banks but not across time, pointing to heterogeneity across banks as the source of residuals heteroskedasticity. The Cumby-Huizinga test for autocorrelation shows a strong presence of autocorrelation (see Table A X). This suggests a partial adjustment mechanism. Introducing on the right-hand side the dependent variable lagged one period and total assets also lagged one period we find that both are statistically significant.

We re-run the regression using Driscoll-Kraay (1998) standard errors since Driscoll-Kraay standard errors assume the error structure to be heteroskedastic, autocorrelated up to some lag and possibly correlated between banks. We retained a specification that adjust the mean only for banks specialized on the card business, as the other adjustment to the mean considered were not statistically significant[3], and introduced on the right-hand side the dependent variable lagged one period and total assets also lagged one period.

[3] The same test applied to specification (2) yields the same conclusion.

Both proved to be statistically significant. A Wald test does not reject that the coefficient of total assets is equal to one (F stat = 0.06, p-value = 0.7995) and that the coefficients of the lagged dependent variable and lagged total assets are symmetric (F stat = 0.05, p-value = 0.8190). This brings the model to a specification on the ratio of Agencies to total assets – see (3) in Table A XI. Since the lagged dependent variable is statistically different from 1 this specification does not match the one used by Rodrigues (1993). The results of the regressions with a lagged dependent variable show that residuals do not exhibit serial correlation. Thus, estimation can proceed using OLS, which are an efficient and consistent estimator since the disturbance term does not exhibit serial correlation.

We introduce bank-fixed effects in (4) – see Table A XII - to control for unobserved time-invariant bank heterogeneity and time-fixed effects to capture bank-invariant time-specific shocks affecting all banks. This, in turn, makes redundant the output gap, whose effects are absorbed by time-fixed effects, and the dummy for card business specialists, as the specificity of these banks is captured by bank-fixed effects. To still capture the effect of the business cycle and regional dynamics, we interact both variables with total assets (in logs).

We test a random effects specification using the Breusch-Pagan LM Test for random effects and a Likelihood Ratio test. In both cases the random effects specification is rejected at a significance level of 5%. Furthermore, we confirm the use of a fixed-effects specification by running a cluster-robust Hausman test which points to the appropriateness of the fixed-effects estimator.

To account for the effects of the Fed asset purchase programmes and the ensuing build-up of banks´ excess reserves deemed exogenous, we add specifications (5) and (6). We saw earlier that cash assets moved in the inverse direction of loans but without replacing government securities. The first specification points for a merely transitory substitution effect as the contemporaneous negative impact is followed by a larger positive lagged effect. In fact, a test on the equality of both coefficients rejects the null. Specification (6) suggests a possible competing role between the two assets only during periods of active asset purchases.

Figure A 3 depicts the trends of four alternative indicators of leverage: the (unadjusted) ratio of equity-to-assets; the reported leverage ratio, which incorporates regulatory adjustments to both equity and assets; the reported tier 1 capital ratio and the total capital ratio, both risk-weighted measures. As can be seen, risk-weighted and non-risk-weighted measures do not always move in the same direction. As was the case recently with the Covid-19 pandemic, a reallocation to safe assets allowed an improvement in risk-weighted measures even if assets growth drove down the leverage ratio. The fact that risk-weighted measures are affected by asset allocation decisions means these specific measures are endogenous. Since our model specification includes a lagged variable dependent variable, to avoid correlation with this variable we lag twice the risk-weighted capital measure used. Note that all these alternative measures have the opposite interpretation of the debt-to-equity ratio. An increase meaning a better capital position.

Results in Table A XIII show that the coefficient of the alternative variables always has the expected negative sign except for the regulatory leverage ratio. However, only the total capital ratio comes closer to be statistically significant. Since the use of this alternative variable reduces the number of observations and there is no improvement in the goodness-of-fit measures we retain the original variable in the base model specification.

To test alternatives to the NPL ratio as an indicator of credit risk of the loan book we used the write-offs ratio, and the ratio of allowances to loan losses to loans. Results are presented in Table A XIV. All coefficients are positive and statistically significant. Both the write-offs ratio and the allowance for loan losses ratio seem acceptable alternatives. We opt for retaining the latter in the base model specification based on the improved serial correlation statistic.

Past profitability measured by the ROA also did not prove statistically significant[4].

The role of Agencies holdings as a shield against unexpected business cycle seems to be statistically significant, contrary to the risks regarding the loan and deposit markets (see Table A XV) This result matches our previous findings for Japan (Ferreira, 2023). Due to the high correlation between the price cost margin and our indicator of diversification, as well as risks of possible endogeneity of the variable, the latter variable enters the model lagged twice. It proves not statistically significant and deteriorates the model serial correlation statistic. Another group of variables is used to verify if the institution profile has an impact on Agencies demand schedule. Results point to unexpected results as we would anticipate that banks with slowest assets growth or worst capital position would have higher holdings of safe assets.

5.1.2 Addressing Potential Endogeneity and Bias

In the event of a bank-specific shock, the affected banking institution probably would adjust its asset allocation and by changing its loan supply would also affect its own and the market loan rate. Since the loan rate affects both the loan rate spread and the margin, we may have correlation between these variables and the random disturbance term. To address possible endogeneity issues, we make use of an instrumental variables (IV) estimator using specification (7) – see Table A XVI. As instruments for both possible endogenous variables we start by using the drivers of the loan rate: the cost of funding, that we proxied by the (log) deposit rate, since the loan-to-deposits ratio is generally below 100%; non-interest expenses, represented by the lagged ratio of general and administrative expenses to loans; and expected loan losses, proxied by the lagged ratio of write-offs to loans, as the allowances for loan losses are an "included" instrument. The latter proved to be redundant and was replaced by the twice lagged ratio of general and administrative expenses to loans and the loan rate spread and margin lagged two or three times.

The presence of many bank event dummies prevented the estimated matrix of moments conditions to be of full rank. Partialling out the event dummies although supposed to

[4] Results not presented for conciseness.

did not change the fact, so we end up removing those dummies. However, the results obtained both ways although different generally point towards the same conclusions. Instruments proved to be valid and relevant, but we cannot dismiss that they may be weak. The weak-instrument robust inference Anderson-Rubin Wald test confirms the significance of the possible endogenous regressors in the structural equation. Results of the endogeneity test mostly suggest that the instrumented variables can be treated as exogenous.

Following this conclusion, our previous specification still suffers from the negative Nickell bias due to the correlation of the lagged dependent variable and the disturbance term created by the within-estimator demeaning process. Applying the simple bias-correction adjustment of Hahn and Kuersteiner (2002) for an AR (1) model with fixed effects we obtain an estimate for the lagged dependent variable of 0.836, that is a negative bias of 10.5%. Nickell own approximation of $-(1+\beta)/(T-1)$ provides an absolute negative bias of 0.092, or an estimate of the true parameter value of 0.841.

As a first approach we make use of the bias corrected least-squares dummy variable estimator that applies the bias approximations of Bruno (2005), who extended the previous work of Bun & Kiviet (2003), Kiviet (1999) and Kiviet (1995).

TABLE III– AGENCIES FIXED EFFECTS BIAS CORRECTION

Variables	(7)		Initialized by BB estimator		Initialized by AB estimator		Iinitialized by AH estimator	
	Coef.	t Stat.	Coef.	t Stat.	Coef.	t Stat.	Coef.	t Stat.
Constant	-0.344	-0.36						
Agencies to total assets (t-1)	0.749 ***	19.84	0.838 ***	39.92	0.828 ***	38.05	0.835 ***	33.18
Loan Rate spread over 30-year Mortgage	0.251 **	2.20	0.263 ***	3.23	0.251 ***	3.10	0.250 ***	3.02
Margin	-0.206 ***	-3.70	-0.189 ***	-3.45	-0.179 ***	-3.35	-0.173 ***	-3.20
Allowance Loan Losses	0.104 ***	5.44	0.083 ***	2.80	0.085 ***	2.95	0.082 ***	2.87
Debt-to-equity	0.053	0.71	0.029	0.54	0.040	0.77	0.040	0.76
CB assets to total assets	0.005	0.86	0.008	0.74	0.007	0.72	0.008	0.79
CB assets to total assets * QE	-0.011	-1.55	-0.014	-1.19	-0.013	-1.18	-0.014	-1.24
GDP to potential GDP x Assets	-0.733 ***	-4.21	-0.483	-1.12	-0.444	-1.05	-0.459	-1.01
Regional to National GDP growth rates x Assets	-0.001	-1.52	-0.001 *	-1.70	-0.001 *	-1.69	-0.001 *	-1.71
Std GDP to potencial GDP x Income diversification	4.903 ***	4.10	4.227 **	1.97	4.363 **	2.09	4.243 **	2.00
Std deposit-to-assets x Mean Loan-to-Deposits	0.068	1.43	0.080	0.97	0.080	0.94	0.091	1.09
Std loan-to-assets x Mean loan-to-assets	-0.702	-1.27	-0.476	-0.48	-0.544	-0.56	-0.482	-0.49
Number of banks	114		114		114		114	
Number of observations	1965		1965		1965		1965	
Dependent Variable	Agencies/Assets		Agencies/Assets		Agencies/Assets		Agencies/Assets	
Estimation	FE DK SE		LSDVC Bootstrap SE		LSDVC Bootstrap SE		LSDVC Bootstrap SE	

Notes: Estimation method – least-squares dummy variable corrected estimator with bootstrap standard errors with 200 replications. BB – Blundell & Bond; AB – Arellano & Bond; AH – Anderson & Hsiao. Bank event dummies had to be removed to make possible the computation of standard errors. Adding the main ones showed no meaningful change. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

Results in Table III show that the estimated coefficient of the lagged dependent variable are close to our previous approximations, and that the significance of the parameters persists in most cases. The exceptions seem to be the lack of a statistically significant response to fluctuations in the business cycle and, on the contrary, the significance of regional dynamics even if only at 10% level.

To further address this issue, we make use of the “system” GMM estimator developed for dynamic panel models with ‘small T, large N’ by Arellano and Bover (1995) and Blundell and Bond (1998) that allows for endogenous regressors. This estimator is efficient and consistent if the models are not subject to serial correlation of order two, the instruments used are valid, and there is no cross-sectional dependence. To overcome the latter constraint Roodman (2009) suggests the introduction of time dummies to prevent contemporaneous correlation, the most likely form of cross-sectional dependence. Given that our panel is unbalanced, the first difference transformation enlarges the gaps in the dataset. This motivates the alternative use of the forward orthogonal deviations' transformation, proposed by Arellano & Bover (1995). The number of instruments produced by the GMM estimator is quadratic on T. Since our T is large, we do not have enough number of observations for all the instruments. Furthermore, GMM is known to have poor finite sample properties when using many overidentifying restrictions. To overcome this problem, we collapse the instruments' matrix into a single column, as in standard IV estimation, and restrict the number of past lags used as instruments. To make estimates as efficient as possible a two- step estimator is used, with the Windmeijer (2005) finite-sample correction applied to covariance matrix to avoid downward biased standard errors. Here again, bank event dummies had to be removed to control the number of instruments and allow meaningful computations. In specification (4) the five main bank events are added, and main results still hold, being the main difference the possible impact of the business cycle.

TABLE IV– AGENCIES DPD SYSTEM GMM ESTIMATES

Variables		(1)		(2)		(3)		(4)	
		Coef.	z Stat	Coef.	z Stat	Coef.	z Stat	Coef.	z Stat
Constant	α	-2.129 ***	-2.77	-1.941 ***	-2.56	-2.029 ***	-2.74	-1.945 **	-2.52
Agencies to total assets (t-1)	β_0	0.830 ***	15.72	0.858 ***	14.59	0.858 ***	14.72	0.852 ***	14.43
Loan Rate Spread	β_1	-0.014	-0.18	0.038	0.48	0.047	0.62	0.034	0.43
Margin	β_2	-0.049	-1.23	-0.072 **	-2.20	-0.072 **	-2.18	-0.072 **	-2.18
Allowance Loan Losses	β_3	0.058 **	1.99	0.052 *	1.76	0.047 *	1.66	0.054 *	1.82
Debt-to-equity	β_4	0.050	0.91	0.055	0.97	0.059	1.10	0.046	0.80
CB assets to total assets	β_5	0.005	0.64	0.003	0.33	0.002	0.31	0.003	0.37
CB assets to total assets * QE	β_6	-0.016	-1.05	-0.015	-0.98	-0.014	-0.89	-0.016	-1.06
GDP to potential GDP x Assets	β_7	-0.334	-1.36	-0.303	-1.27	-0.319	-1.37	-0.397 *	-1.65
Regional to National GDP growth rates x Assets	β_8	-0.001 **	-2.13	0.000	-1.41	0.000 *	-1.71	0.000	-1.22
Std GDP to potencial GDP x Income diversification	β_9	4.340 *	1.75	3.510	1.41	3.750	1.53	3.427	1.35
Std deposit-to-assets x Mean Loan-to-Deposits	β_{10}	-0.141	-1.07	-0.144	-1.16	-0.143	-1.17	-0.136	-1.08
Std loan-to-assets x Mean loan-to-assets	β_{11}	-0.032	-0.13	0.076	0.33	0.067	0.29	0.063	0.27
Wald χ2		112454 ***		114222 ***		121581 ***		7.E+08 ***	
df		30		30		30		36	
Arellano-Bond test for AR(2) in first differences (p-value)		0.898		0.863		0.867		0.653	
Hansen J test of over-identifying restrictions (p-value)		0.784		0.349		0.445		0.414	
Number instruments		33		34		35		40	
Number of banks		114		114		114		114	
Number of observations		1965		1965		1965		1965	
Lags instrumenting lagged dependent variable		(1 2)		(1 3)		(1 4)		(1 3)	

Notes: Estimation method – System GMM with forward orthogonal deviations and collapsed instruments on the lagged dependent variable. No external instruments are used. Bank event dummies have been removed except for the last specification that includes the five most significant ones. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

5.1.3 Final Results

The results of Table IV confirm a large autoregressive coefficient, but statistically different from one. Thus, we fail to validate the option of Rodrigues (1993) to use as dependent variable the change in the securities-to-assets ratio. In Ferreira (2023) we found the same result for Japan. Although the speed of adjustment is slow in the US (15.1% per year), the half-life for the adjustment is 4.2 years, below our estimate of 5.5 years for Japan.

Evidence regarding the loan rate spread is mixed. Previous estimates pointed to an unexpected positive relationship, out of line with previous findings for the US. The GMM estimates change sign and are never very meaningful from a statistical point of view. This result is not unexpected since we had remarked that loan contraction and expansion was mainly compensated by an expansion and reduction in banks' excess reserves rather than in government securities. Furthermore, similar findings can be found in Japan, suggesting an unintentional side effect of LSAP programmes.

On the contrary, the price cost margin is consistently significant even though its impact changes substantially between the LSDVC and the GMM estimates. Higher loan margins incentivize banks to replace Agencies with higher expected return loans. This mirrors the findings of Ogawa & Imai (2014) for Japan, but not our owns nor those of Buch et al. (2016) regarding German banks.

Lower loan portfolio quality proxied by allowances for loan losses induces larger holdings of Agencies across different estimates. This result also matches previous findings for the US, our owns and of Ogawa & Imai (2014) for Japan, and Affinito et al. (2022) for Italy.

Leverage always exhibits the expected positive relationship with Agencies holdings but is always far from being statistically significant. This lack of statistical significance comes as a surprise since previous findings for the US suggested otherwise, as well as evidence from Japan (Ogawa & Imai, 2014; Ferreira, 2023), Germany (Buch et al., 2016) or Italy after the euro sovereign debt crisis (Affinito et al., 2022).

The negative impact of liquid central bank assets during QE periods indicating asset replacement faded with the introduction of business cycle risk and is no longer visible in our final estimates. The lack of a substitution effect may result from banks efforts to improve their capital position as the share of not well capitalized institutions increased from 1.6% to 6.2% between 2007 and 2009 by investing excess reserves in safer assets such as Agencies before improvement of economic conditions made lending attractive again.

The impact of the business cycle is uncertain. In most of the last estimates it fails to be statistically significant. However, the reason why is not entirely clear. It could be a lack of Agencies response to movements in loans as with the loan rate spread, or a consequence of the lack of bank event dummies in most of the last GMM and LSDVC estimates. In fact, in the GMM specification (4) where some bank events were introduced the statistical significance of the variable improves.

Regional dynamics tend to be in the borderline of statistical significance, but results indicate that in states with above average GDP growth rates banks tend to have lower relative holdings of Agencies and this effect is higher for larger banks.

Precautionary motives to hold Agencies do not apply to risk in the loan and deposit markets, while the evidence regarding business cycle risk is unclear. In fact, the standard deviation of the output gap in interaction with a diversification indicator has a positive impact on bank holdings of Agencies, larger for less diversified banks, in all estimates but our last GMM estimates. Therefore, the impact of risk in banks' asset portfolio allocation in the US remains an open question.

Past profitability level of income diversification or bank profile features such as asset size, asset growth, or capital position do not seem to have a significant impact in Agencies bank demand.

5.2 Extended Treasuries

5.2.1 Baseline Specifications

To derive our baseline specifications for Extended Treasuries we followed identical procedure to the one we took for Agencies. The results of the different steps are presented in the Appendix in Table A XVII to Table A XXII.

In the case of Extended Treasuries, the stronger presence of serial correlation required the introduction of a second lag of the dependent variable in the right-hand side. The corresponding parameter within estimate is negative seemingly reducing persistence in comparison with Agencies.

The loan rate spread rarely is statistically significant and was dropped out from our final specification. Allowance for loan losses presents a higher and more significant elasticity.

The margin exhibits the expected negative sign and banks less well capitalized seem to respond to an improvement by shedding a larger proportion of Extended Treasuries.

A more significant contrast is the fact that leverage is now always statistically significant, pointing to an increase in safe assets in response to a deterioration of the capital position (increase in leverage). However, banks less well capitalized are relatively not so eager to increase Extended Treasuries holdings, while the best capitalized banks go even further than the average in safeguarding their asset portfolio. In specification (9) of Table A XXII we can see that banks with the worst capital position hold a lesser proportion of Extended Treasuries, providing support for the proposition of Rochet (1992) that in such cases shareholders limited liability clause drives banks to riskier asset portfolios.

Another difference relates with balances at the central bank. Within estimates indicate a general positive effect, which turns negative during the LSAP programmes, only to become more strongly positive once the Fed began its first balance sheet reduction in 2018-19.

The business cycle and regional dynamics have no bearing in banks' allocation to Extended Treasuries. On what regards risk, as with Agencies, only business cycle risk seems to be relevant.

5.2.2 Addressing Potential Endogeneity and Bias

In this part of our research, we need to remove bank event dummies because they interfere with model estimation. To assess the impact of this decision we compare in Table V, specifications (10) and (11), equal in all aspects but bank event dummies which are not present in (11). We conclude that the impact is minor, as the significance of the variables is not affected, and parameter estimates are only slightly different.

In our Extended Treasuries final specification, we dropped out the loan rate spread but still have the margin as a possible endogenous variable. We investigate this possible endogeneity issue using an IV estimator. Results are presented in Table A XXIII using different sets of instruments. As with Agencies, we conclude that the variable is exogenous.

TABLE V – EXT. TREASURIES FIXED EFFECTS BIAS CORRECTION

Variables	(10)			(11)			(12)		
	Coef.		t Stat.	Coef.		t Stat.	Coef.		t Stat.
Constant	-			-			-		
Ext. Treasuries to total assets (t-1)	0.766	***	15.12	0.761	***	15.52	0.843	***	14.35
Ext. Treasuries to total assets (t-2)	-0.096	***	-4.57	-0.095	***	-4.72	-0.050		-1.60
Margin	-0.229	***	-3.50	-0.203	***	-3.00	-0.212	*	-1.82
Allowances for loan Losses	0.279	***	6.79	0.260	***	9.13	0.240	***	2.80
Debt-to-equity	0.638	***	5.10	0.662	***	5.51	0.598	***	3.73
CB assets to total assets	0.026	***	2.81	0.026	***	3.07	0.031		1.55
CB assets to total assets * QE	-0.049	**	-2.46	-0.045	**	-2.26	-0.053	*	-1.76
CB assets to total assets * Taper	0.044	**	2.52	0.054	***	2.85	0.042		1.15
Std GDP to potencial GDP x Income non-diversification	2.648	**	2.56	2.743	**	2.52	3.360		0.75
Worst capital position banks#Margin	-0.189	***	-3.47	-0.191	***	-3.63	-0.171		-1.39
Worst capital position banks#Debt-to-equity	-0.104	***	-4.47	-0.110	***	-5.06	-0.104	***	-2.76
Best capital position banks#Debt-to-equity	0.104	***	4.33	0.113	***	5.52	0.119	***	3.64
F Stat.	4537.7	***		90511.0	***				
df	(104, 104)			(31, 104)					
No bank fixed effects F Stat	2.10	***		2.09	***				
df	(104,1521)			(104,1587)					
No time fixed effects F Stat	5.90E+04	***		5.48E+04	***				
df	(17,104)			(17,104)					
Adj. R^2	0.7934			0.7937					
Root MSE	0.7255			0.7406					
AIC	3697.9			3768.8					
Cumby-Huizinga Autocorrelation Test									
$\chi^2(4)$ Stat.	1.315			2.621					
Number of banks	105			105			105		
Number of observations	1721			1721			1683		
Dependent Variable	Ext. Treas./Assets			Ext. Treas./Assets			Ext. Treas./Assets		
Estimation	FE DK SE lag=4			FE DK SE lag=4			BCFE BS SE CSHET		

Notes: DK SE - Driscoll-Kraay (1998) standard errors; FE – fixed-effects; BCFE BS SE CSHET –Bootstrap-corrected fixed-effects estimator for dynamic panel-data models of general AR order (p). The estimator corrects the small T Nickell (1981) bias using a simplified but extended version of the approach presented in Everaert and Pozzi (2007) of an algorithm that evaluates the bias of fixed effects in a numerical way to avoid the use of analytical correction formulas, allowing for several heteroskedasticity and cross-sectional dependence patterns through the choice of resampling schemes. CSHET – Cross-section heteroskedasticity indicating that error terms are resampled within cross-sections. CSD - Cross-Sectional Dependence, specifying that time indices are resampled identically for all cross-sections, while keeping error terms cross-section specific. It requires strongly balanced panels. MSE - Mean squared error; AIC – Akaike information criteria; all variables in logs; estimates of coefficients associated with time and bank fixed effects are omitted; F Stat. is the statistic of the F-test of overall significance; $\chi2(4)$ is the statistic of the Cumby-Huizinga test of serial correlation up to lag 4 with a null hypothesis of no serial correlation robust to within-cluster arbitrary correlation and between-cluster heteroskedasticity. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

The presence of two lags of the dependent variable in the regressors do not allow the use of the least squares dummy variable correction employed in the case of Agencies. In alternative we use a bootstrap-corrected fixed-effects estimator for dynamic panel-data models of general autoregressive order p. The estimator corrects the small T Nickell bias using an algorithm that evaluates the bias of fixed effects in a numerical way to avoid the use of analytical correction formulas, allowing for several heteroskedasticity and cross-sectional dependence patterns through the choice of the resampling schemes. In Table V we use resampling within cross-sections to account for heteroskedasticity. Resampling to account for cross-sectional dependence requires a strongly balanced panel. This means moving from a sample of 105 banks to 68 banks. Such large difference may affect the results more significantly than the mere change of resampling scheme. Indeed, in Table A XXIV we present the results for such case using both methods of resampling. The difference between the two resampling methods seems minor. Thus, we will focus on the results of the larger sample of banks.

TABLE VI – Ext. Treasuries DPD System GMM Estimates

Variables	(1)			(2)			(3)		
	Coef.		z Stat	Coef.		z Stat	Coef.		z Stat
Constant	-0.844	**	-2.52	-0.727	**	-2.46	-0.673	***	-2.63
Treasuries to total assets (t-1)	0.873	***	13.49	0.894	***	15.25	0.902	***	16.35
Treasuries to total assets (t-2)	-0.052		-1.22	-0.056		-1.32	-0.054		-1.26
Margin	-0.023		-0.33	-0.009		-0.12	-0.008		-0.12
Allowances for loan Losses	0.112	***	2.72	0.107	***	2.61	0.106	***	2.59
Debt-to-equity	0.480	**	2.52	0.420	**	2.48	0.386	***	2.75
CB assets to total assets	0.013		0.83	0.011		0.72	0.009		0.64
CB assets to total assets * QE	-0.019		-0.78	-0.019		-0.73	-0.014		-0.65
CB assets to total assets * Taper	0.029		0.86	0.028		0.81	0.027		0.78
Std GDP to potencial GDP x Income non-diversification	4.441		1.18	3.895		1.01	4.081		1.07
Worst capital position banks#Margin	-0.154	**	-2.15	-0.162	**	-2.28	-0.161	**	-2.26
Worst capital position banks#Debt-to-equity	-0.072	**	-2.27	-0.068	**	-2.25	-0.064	**	-2.32
Best capital position banks#Debt-to-equity	0.083	***	2.59	0.073	**	2.40	0.068	**	2.49
Wald χ2	3537	***		3602	***		3629	***	
df	29			29			29		
Arellano-Bond test for AR(2) in first differences (p-value)	0.363			0.370			0.361		
Hansen J test of over-identifying restrictions (p-value)	0.173			0.224			0.324		
Number instruments	33			34			35		
Number of banks	105			105			105		
Number of observations	1721			1721			1721		
Period									
Lags instrumenting lagged dependent variable	(1 2)			(1 3)			(1 4)		

Notes: Estimation method – System GMM with forward orthogonal deviations and collapsed instruments on the lagged dependent variable. No external instruments are used. Bank event dummies have been removed. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

Bootstrap fixed-effects bias correction impact previous results in four different ways:

1) The second lag of the dependent variable becomes statistically nonsignificant, and persistence is close to the estimates for Agencies.
2) The statistical significance of the margin is reduced to 10%, fading altogether for its interaction with the capital position.
3) Central bank assets keep relevance only for the QE episodes.
4) Business cycle risk is no longer statistically significant.

5.2.3 Final Results

To further address this issue, we make use of the “system” GMM estimator. Results are presented in Table VI. Details regarding sub-samples are presented in Table A XXV.

System GMM estimates confirm the lack of significance of the second lag of the dependent variable. Considering the average of the coefficients of the once lagged dependent variable across specifications we arrive at a speed of adjustment of 11%, and a half-life of the adjustment of 5.9 years, above our findings for Agencies and closer to our results for Japanese Government Bonds (JGB).

Margin loses statistical significance and becomes only important for less well capitalized banks and for State Non-Member Banks of the Federal Reserve System. Allowance for loan losses and leverage, including its interaction with the capital position, remain statistically significant.

Central bank assets lose their statistical significance when we consider the all-sample period. However, focusing only in the 2008-15 period, the general positive effect and the negative impact of LSAP programmes turnout meaningful. Furthermore, National and State Member Banks display the general positive relationship, although at a 10% significance level.

Puzzlingly, State Non-Member Banks exhibit a statistically strong general negative relationship, and a smaller positive, though not statistically significant, relationship for QE periods. The result seems odd, considering that holdings hovered around 3-4.4% of assets and central bank balances increase over the period. On the contrary, during QE both variables seem flat, so the lack of a significant relationship may be understandable.

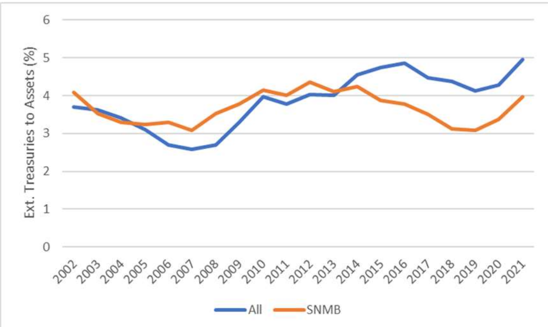

FIGURE 15 – EXT. TREASURIES TO ASSETS
Source: FFIEC. Author’s calculations.

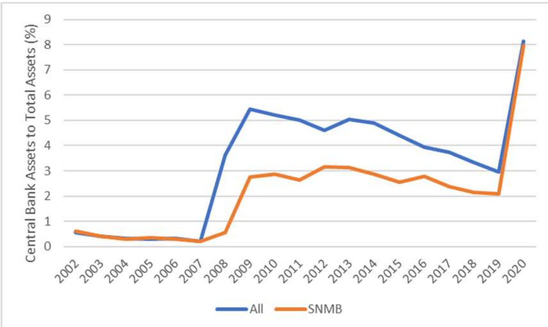

FIGURE 16 – CENTRAL BANK ASSETS TO ASSETS
Source: FFIEC. Author’s calculations.

We fear the odd result may be related with the estimator since the number of banks fall to 34 and we may be stretching excessively the “small T large N” estimator’s framework.

6. CONCLUSIONS

The aim of this paper is to provide empirical insights on the drivers of US banks’ demand of government securities comprising both all US Government agency and sponsored agency obligations directly or indirectly government-guaranteed (Agencies) and securities of the federal government, states, and political subdivisions in the US (Extended Treasuries).

Our analysis is based on the micro foundations of banks' asset allocation decisions and hence closely related with the strand of empirical literature focusing on the bank-specific characteristics determinants of sovereign debt holdings. We use individual bank balance sheet data to investigate those characteristics that are relevant to explain separately bank demand for Agencies and Extended Treasuries as the two aggregates of government securities exhibit different trends over the sample period of 2002-21.

We conclude that both aggregates of government securities share some common determinants, but the drivers are not entirely the same.

In both cases, price signals conveyed by the loan rate spread do not seem statistically significant. This result is not unexpected since we had remarked that loan contraction and expansion was mainly compensated by an expansion and reduction in central bank assets rather than in government securities. Furthermore, similar findings can be found in Japan, suggesting an unintentional side effect of LSAP programmes.

As Rodrigues (1993), we find that for both types of government securities poorer loan quality is associated with higher holdings of the safe assets. However, Extended Treasuries elasticity is about two times the one found for Agencies, which is the reverse of the results of Rodrigues (1993). The relationship found matches identical findings for other countries, such as Ogawa & Imai (2014) and Ferreira (2023) for Japan, and Affinito et al. (2022) for Italy.

Evidence regarding the price cost margin and leverage is no longer homogeneous. If higher margins incentivize banks to replace Agencies with higher expected return loans the effect is less clear for Extended Treasuries, as the variable statistical significance depends on the method used to correct the Nickell bias. The bootstrap correction suggests the relevance of the variable alone, while according with system-GMM estimates the relation holds only for banks less well capitalized and for State Non-Member Banks of the Federal Reserve System.

On what concerns financial leverage (debt-to-equity), the variable shows the expected positive relationship with Agencies but is never statistically significant, contrary to what we verify with Extended Treasuries. This suggests that more liquid Treasuries are the preferred variable of adjustment of the asset portfolio risk in response to a worsening of banks' capital position. Furthermore, this variable interaction with the capital position indicates that the response is larger for well capitalized banks and smaller for less well capitalized ones, pointing to a relative riskier behaviour of the latter. In fact, when the capital position enters on a standalone basis the Extended Treasuries' regression, it confirms Rochet (1992) proposition that shareholders limited liability clause drives less well capitalized banks to hold relatively lower levels of the riskless asset. A proposition that when tested in Japan produced the correct sign but failed to be statistically significant (Ferreira, 2023). Our general findings for the impact of financial leverage are in line with the results of Acharya & Steffen (2015), Buch et al. (2016) Affinito et al., (2022), Ogawa & Imai (2014) and Ferreira (2023), for other countries.

Other bank-specific characteristics such as past profitability, size or business diversification have no bearing on bank allocation to Agencies or Extended Treasuries, tough we find signs suggesting the banks having the most difficulties to grow their assets tend to have slightly lower relative holdings of Agencies.

Macro drivers such as the business cycle and regional relative economic dynamics do not play a role in the allocation to Treasuries. The situation regarding Agencies is less clear as evidence is mixed. When it holds, it points to lesser degree of Agencies holdings when the national or the regional economy is booming.

Results indicate that risks related to the loan and deposit market do not seem to have a relevant role in government securities bank demand. The only risk that shows some relevance is business cycle risk. In the case of Agencies, it persists after bias correction, although not in all system-GMM estimates, while it fades completely for Extended Treasuries. Thus, contrary to our findings for Japan (Ferreira, 2023), the impact of risk remains an open empirical question in the case of the US.

An issue relevant from a policy point of view is the effect of unconventional monetary policy in government securities bank demand. The impact of LSAP programmes in our setting is assessed using banks' cash assets at the central bank whose mean weight increased from less than 1% to 9.9% over 2002-21. The programmes were run at specific dates and not continuously as in Japan. Despite the presence of MBS on some of Fed's LSAP programmes, Agencies do not exhibit a statistically significant relationship with cash assets. Extended Treasuries show a general positive relationship with excess reserves (as in Buch et al.,2016), that turns negative during Fed buying periods, and more positive when the Fed started to reduce its balance sheet before bias correction. Bootstrap bias correction leaves only the Fed buying periods as statistically significant, while none is so under system-GMM estimates. Only when we restrict the sample to the 2008-15 period does the general positive relationship and the Fed buying periods effect regain significance, or just the general relationship, but with opposite signs, when we differentiate between National and State Member Banks and State Non-Member Banks. The difficulty in finding a clear relation may be related to the fact that looking at yearly means, banks have increased their holdings of government securities in 2008-11 and again in 2020-21 in response to the deterioration of the economic situation, despite Fed purchases. This situation is different from what we have found for Japan, where Bank of Japan's purchases translated in a negative relationship. Our results suggest the absorption of excess reserves associated with Fed's balance sheet reduction, *ceteris paribus*, may induce sales by National and State Member Banks, and possible purchases by State Non-Member Banks. Hence, it will be mainly up to other investors to replace the central bank as final holders of Treasuries.

The present empirical analysis could be extended by modelling the allocation of Treasuries with endogenous sample selection.

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Appendix

Preliminary

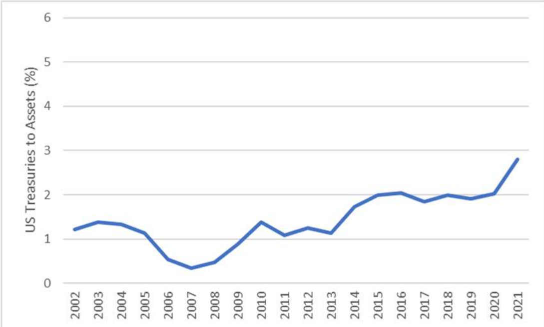

Figure A 1 – US Treasuries

Source: FFIEC. Author's calculations.

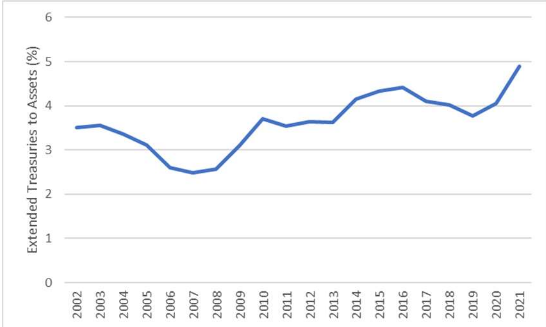

Figure A 2 – Extended Treasuries

Source: FFIEC. Author's calculations.

Table A I – Regressions of Changes in Loans

	(1)			(2)			(3)			(4)		
	Coef.		t Stat.	Coef.		t Stat.	Coef.		t Stat.	Coef.		t Stat.
Constant	0.000		-1.25	-0.001	**	-2.13	0.000		0.03	0.000		0.62
Δ Treasuries and agencies	-0.041	*	-1.82	-0.086	***	-2.70	0.038		0.85	-0.330	***	-7.21
Δ Cash assets	-0.080	***	-12.93	-0.090	***	-4.42	-0.078	***	-9.79	-0.163	***	-13.56
Δ Loans & leases (t-1)	0.156	***	3.24									
F Stat.	81	***		11.53	***		55.48	***		100.9	***	
df	(3, 258)			(2, 92)			(2, 93)			(2, 69)		
Adj. R^2	0.4777			0.2005			0.5342			0.7374		
Root MSE	0.0046			0.0043			0.0052			0.0032		
AIC	-2077.0			-763.8			-736.1			-619.5		
Breusch-Godfrey LM test χ^2 (1) Stat.	2.453			0.290			2.328			0.179		
Number of observations	263			95			96			72		
Period	2000-21			2000-07			2008-15			2016-21		
Dependent Variable	Loans and leases			Loans and leases			Loans and leases			Loans and leases		
Estimation	OLS			OLS			OLS			OLS		

Notes: Estimation method – Ordinary Least squares; MSE - Mean squared error; AIC – Akaike information criteria; all variables in logs; F Stat. is the statistic of the F-test of overall significance; χ2(1) is the statistic of the Breusch-Godfrey LM test of autocorrelation with a null hypothesis of no serial correlation. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

Table A II –Non-Parametric test on the equality of medians

US Ext. Treasuries holdings / Assets

H_0: the K samples were drawn from populations with the same median.

Group	χ^2 Stat	df	p-value
Entity	15.4694	4	0.0040
Charter Type	10.8409	2	0.0040

Notes: Entities are National Bank, State Member Bank, State Non-Member Bank, Federal Savings Bank, and Savings Bank. Charter types are Commercial, Savings and Industrial Banks. Source: Author own calculations on data from FFIEC.

Agencies Holdings / Assets

H_0: the K samples were drawn from populations with the same median.

Group	χ^2 Stat	df	p-value
Entity	18.8102	4	0.0010
Charter Type	26.7284	2	0.0000

Notes: Entities are National Bank, State Member Bank, State Non-Member Bank, Federal Savings Bank, and Savings Bank. Charter types are Commercial, Savings and Industrial Banks. Source: Author own calculations on data from FFIEC.

TABLE A III – US EXT. TREASURIES HOLDINGS DESCRIPTIVE STATISTICS

Bank Type	Obs	Median	Mean	Std	Skew	Kurt
National Banks	749	2.38	4.01	5.30	2.74	12.64
State Member Banks	552	2.50	4.20	5.60	3.09	15.50
State Non-Member Banks	668	2.57	3.67	3.46	1.32	4.67
Federal Savings Banks	41	2.09	2.76	3.10	1.12	3.19
State Savings Banks	40	0.91	2.07	3.19	2.22	8.26
Commercial Banks	1950	2.50	3.96	4.86	2.89	15.24
Savings Banks	81	1.07	2.42	3.15	1.65	5.51
Industrial Banks	19	1.99	2.91	3.89	1.82	5.45
Federal	790	2.39	3.98	5.20	2.78	13.04
State	1260	2.47	3.83	4.55	2.97	17.29
Card	71	1.49	2.15	2.66	1.75	6.35
Non-card	1979	2.49	3.95	4.86	2.88	15.15
Foreign	159	2.89	4.19	5.00	2.18	8.83
Non-foreign	1891	2.41	3.86	4.79	2.97	16.04

Notes: Median, mean, standard deviation, skewness, and kurtosis for different groupings of sampled US banks over 2002-21. Source: Author own calculations on data from FFIEC.

TABLE A IV – US EXT. TREASURIES HOLDINGS: SELECTED EQUAL MEANS T-TEST

Bank Type i	Bank Type j	t Stat	df	p-value
State Member Banks	National Banks	0.786	551	0.4325
State Non-Member Banks	National Banks	-2.534	667	0.0115
Savings	Commercial	-4.394	80	0.0000
Federal	State	-0.702	2048	0.4826
Card	Non-card	5.384	88	0.0000
Foreign	Non-foreign	-0.831	2048	0.4059

Notes: Satterthwaite's degrees of freedom are used in the Card/Non-card test since the variance is unequal across groups. Source: Author own calculations on data from FFIEC.

Table A V – US Agencies Holdings Descriptive Statistics

Bank Type	Obs	Median	Mean	Std	Skew	Kurt
National Banks	779	12.29	12.65	7.17	0.43	3.14
State Member Banks	616	11.23	13.41	9.54	1.33	4.72
State Non-Member Banks	705	11.35	12.87	9.57	1.21	4.86
Federal Savings Banks	61	7.15	8.07	8.30	1.67	6.37
State Savings Banks	54	13.98	22.61	20.06	0.99	2.88
Commercial Banks	2064	11.86	13.09	8.71	1.16	4.94
Savings Banks	115	8.60	14.90	16.62	1.71	5.39
Industrial Banks	36	1.19	4.70	7.00	2.03	6.33
Federal	841	11.60	12.06	7.33	0.56	3.33
State	1375	11.58	13.66	10.32	1.53	6.41
Card	111	0.73	3.36	4.72	1.55	4.80
Non-card	2104	12.05	13.56	9.23	1.51	6.94
Foreign	189	11.86	11.96	7.66	0.67	3.90
Non-foreign	2026	11.52	13.15	9.46	1.48	6.77

Notes: Median, mean, standard deviation, skewness, and kurtosis for different groupings of sampled US banks over 2002-21. Source: Author own calculations on data from FFIEC.

Table A VI – US Agencies Holdings: Selected Equal Means T-Test

Bank Type i	Bank Type j	t Stat	df	p-value
State Member Banks	National Banks	1.980	615	0.0481
State Non-Member Banks	National Banks	0.613	704	0.5403
Savings	Commercial	1.165	114	0.2466
Federal	State	4.253	2164	0.0000
Card	Non-card	20.785	159	0.0000
Foreign	Non-foreign	2.011	245	0.0454

Notes: Satterthwaite's degrees of freedom are used in the three last t-tests since the variance is unequal across groups. Source: Author own calculations on data from FFIEC.

Table A VII – Correlation Coefficients of Main Explanatory Variables of US Banks Portfolio Allocation Model

	Loan rate spread	Margin	NPL ratio	Leverage	CB assets to Total Assets	ROA	Output Gap	Relative Growth Rates	Std loan to assets ratio	Std deposit to assets ratio	Std Output Gap	Diver-sification
Loan rate spread	1											
Margin	0.4561	1										
NPL ratio	0.2834	0.0336	1									
Leverage	-0.2517	-0.2351	-0.0648	1								
CB assets to total assets ratio	0.0470	-0.0414	0.0543	-0.0329	1							
ROA	0.3254	0.1943	-0.1571	-0.0682	-0.1284	1						
Output Gap	-0.0384	0.0006	-0.3241	0.0707	-0.2850	0.2585	1					
Relative GDP growth rates	0.0364	0.1044	-0.1175	-0.0153	0.0095	0.0749	-0.0364	1				
Std loan-to-assets ratio	0.0281	-0.0252	0.2549	0.0085	0.1901	-0.2200	-0.6081	0.0255	1			
Std deposit-to-assets ratio	-0.0935	-0.1703	0.1140	0.1295	-0.3635	-0.0680	-0.0216	0.0117	0.1169	1		
Std Output Gap	0.1314	0.0625	-0.0108	0.0269	0.2110	-0.0817	-0.2436	0.0613	0.3490	-0.2582	1	
Diversification	0.2697	0.7782	-0.0237	-0.0760	-0.1637	-0.0830	0.0638	0.0546	-0.0395	-0.0324	0.0174	1

Notes: All variables are computed in logs but the standard deviations. The calculation period is 2002 to 2021. Source: Author's calculations on data from FFIEC, US Federal Reserve, US Bureau of Economic Analysis, World Bank and Bloomberg.

Table A VIII – US Cross-sectional Dependence Tests

	Pesaran (2004) CD Statistic		Pesaran (2015) CD Statistic	
Log US Treasuries and Local Gov. Bonds	111.17	***	112.13	***
Log Agencies Bonds	135.44	***	291.58	***
Log Total Bank Assets	296.59	***	287.32	***
Log US Treasuries and Local Gov. Bonds/Assets	10.550	***	9.9910	***
Log Agencies Bonds/Assets	25.990	***	280.23	***
Log Loan Rate / 10-year UST yield	296.13	***	290.39	***
Log Loan Rate / 30-year Mortgage Rate	149.07	***	131.98	***
Log Margin	43.080	***	43.470	***
Log NPL/Gross Loans	157.56	***	139.62	***
Log (Gross) Charge-Offs	173.09	***	165.69	***
Log Debt-to equity	60.380	***	29.152	***
Log Reported Leverage Ratio	67.090	***	102.45	***
Log CB assets to Total Assets	134.97	***	150.98	***
Log of Regional and National GDP real growth rate	4.3000	***	4.3020	***
Log ROA	69.060	***	55.104	***
Log Diversification	56.680	***	40.871	***

Notes: The asterisks ***, **, * indicate significance at the 1, 5, 10% level. Pesaran (2004) has a null hypothesis of cross-sectional independence; Pesaran (2015) has a null hypothesis of weal cross-sectional independence. The tests are conducted over the period 2002-21. Tests over Treasuries and Agencies cover 84 and 93 banks since tests require a minimum number of observations, although allowing and adjusting for unbalanced panels. Source: Author's calculations on data FFIEC, US Federal Reserve, US Bureau of Economic Analysis, World Bank and Bloomberg.

Agencies

TABLE A IX – US AGENCIES HETEROSKEDASTICITY TESTS

H_0: constant variance of residuals			
Breusch-Pagan/Cook-Weisberg Test			
$\chi^2(1)$ Stat	p-value	F(1 , 2132)	p-value
98.0	0.0000	21.5	0.0000

H_0: equality of variances across banks					
Brown and ForsytheTest				Levene Test	
W50		W10		W0	
F(116 , 2017)	p-value	F(116 , 2017)	p-value	F(116 , 2017)	p-value
10.1750	0.0000	15.8717	0.0000	18.2205	0.0000

H_0: equality of variances across time (years)					
Brown and ForsytheTest				Levene Test	
W50		W10		W0	
F(19 , 2114)	p-value	F(19 , 2114)	p-value	F(19 , 2114)	p-value
0.9727	0.4909	0.9985	0.4593	1.1133	0.3296

Notes: Test on residuals from OLS regression of equation (1) over the period 2002-21 and 116 banks. The Levene test uses the mean (W0) as a measure of centre. Brown and Forsythe replace this measure with the median (W50) and with the 10% trimmed mean (W10). Conover, Johnson, and Johnson (1981) compare the properties of the mean and median tests and recommend using the median test for asymmetric data, as is the case of the US data. Source: author's calculations.

TABLE A X – US AGENCIES SERIAL CORRELATION TEST

H_0: Serially Uncorrelated Ha: Serial correlation at range specified					H_0: Moving Average up to order lag-1 Ha: Serial correlation at lag j			
Lags Range From	To	χ^2 Stat.	df	p-value	Lag	χ^2 Stat.	df	p-value
1	1	183.165	1	0.0000	1	183.165	1	0.0000
1	2	183.899	2	0.0000	2	66.072	1	0.0000
1	3	184.201	3	0.0000	3	39.806	1	0.0000
1	4	185.771	4	0.0000	4	27.388	1	0.0000
1	5	185.901	5	0.0000	5	20.004	1	0.0000
1	6	185.929	6	0.0000	6	15.572	1	0.0001
1	7	186.146	7	0.0000	7	11.969	1	0.0005
1	8	187.877	8	0.0000	8	8.169	1	0.0043

Notes: Test robust to heteroskedasticity. df = degrees of freedom. Source: Author's calculations.

TABLE A XI - INITIAL US AGENCIES MODEL SPECIFICATIONS

Variables	(1) Coef.	(1) t Stat.	(2) Coef.	(2) t Stat.	(3) Coef.	(3) t Stat.
Constant	-2.153 ***	-8.10	-0.410 ***	-3.02	-0.400 ***	-3.51
Total Assets	0.955 ***	76.61	0.985 ***	11.39		
Agencies to total assets (t-1)					0.864 ***	33.23
Loan rate spread	0.482 ***	4.85	0.098	1.26	0.100	1.23
Margin	-0.416 ***	-9.35	-0.062 **	-2.59	-0.064 ***	-3.10
NPL ratio	-0.032 *	-1.72	-0.001	-0.06	0.000	-0.02
Debt-to-equity	0.246 ***	3.53	0.027	1.10	0.025	1.04
GDP to potential GDP	-1.765	-1.36	-1.221	-0.80	-1.362	-0.90
Regional to National GDP growth rates	-0.054 ***	-4.80	-0.010	-1.49	-0.900	-1.34
Card Business Specialized Banks	-2.743 ***	-22.36	-0.459 ***	-4.14	-0.460 ***	-4.06
Foreign Banks	0.145 *	1.94	-0.007	-0.46	-0.007	-0.46
State Member Banks	-0.071	-1.47	-0.003	-0.18	-0.003	-0.24
State Savings Banks	0.264 *	1.94	-0.004	-0.05	-0.013	-0.02
Agencies (t-1)			0.864 ***	33.26		
Assets (t-1)			-0.848 ***	-9.60		
F Stat.	91 ***		41400 ***		39336 ***	
df	(84, 2049)		(86, 116)		(84, 116)	
Root MSE	0.9158		0.4397		0.4373	
AIC	5763.9		2374.6		2350.7	
Breusch-Pagan Heteroscedasticity Test						
$\chi 2(1)$ Stat.	93.1 ***					
Cumby-Huizinga Autocorrelation Test						
$\chi^2(4)$ Stat.	189.933 ***		3.237		2.778	
Number of banks	117		117		117	
Number of observations	2134		2038		2038	
Dependent Variable	Agencies		Agencies		Agencies/Assets	
Estimation	OLS		FE DK SE lag=4		FE DK SE lag=4	

Notes: DK SE - Driscoll-Kraay (1998) standard errors; FE – fixed-effects; MSE - Mean squared error; AIC – Akaike information criteria; all variables in logs; estimates of coefficients associated with time and bank fixed effects are omitted; F Stat. is the statistic of the F-test of overall significance; $\chi 2(1)$ is the statistic of the Breusch-Pagan/Cook-Weiberg heteroskedasticity test with a null hypothesis of t = 0 in Var(e_i)=σ^2 . exp(zt), where z is the fitted values; $\chi 2(4)$ is the statistic of the Cumby-Huizinga test of serial correlation up to lag 4 with a null hypothesis of no serial correlation robust to within-cluster arbitrary correlation and between-cluster heteroskedasticity. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

TABLE A XII - US AGENCIES MODEL SPECIFICATIONS WITH CENTRAL BANK ASSETS

Variables	(4) Coef.	(4) t Stat.	(5) Coef.	(5) t Stat.	(6) Coef.	(6) t Stat.
Constant	-1.190 ***	-4.95			-0.627 ***	-3.82
Agencies to total assets (t-1)	0.755 ***	17.08	0.729 ***	19.12	0.733 ***	18.87
Loan rate spread	0.272 ***	2.77	0.264 **	2.46	0.279 **	2.52
Margin	-0.199 ***	-4.03	-0.189 ***	-3.43	-0.216 ***	-3.98
NPL ratio	-0.006	-0.37	0.006	0.46	0.008	0.56
Debt-to-equity	-0.005	-0.10	-0.003	-0.05	-0.008	-0.12
GDP to potential GDP x Assets	-0.932 ***	-3.81	-0.967 ***	-3.93	-0.907 ***	-3.58
Regional to National GDP growth rates x Assets	-0.001 **	-2.10	-0.001	-1.59	-0.001	-1.57
CB assets to total assets			-0.017 ***	4.44	0.007	1.14
CB assets to total assets (t-1)			0.031 ***	-3.93		
CB assets to total assets * QE					-0.014 **	-2.49
CB assets to total assets * Taper					-0.008	-0.71
F Stat.	2065.46 ***		2964.54 ***		2580.4 ***	
df	(100, 116)		(102, 116)		(103, 116)	
No bank fixed effects F Stat	2.21 ***		2.5 ***		2.34 ***	
df	(116,1824)		(116,1739)		(116,1764)	
No time fixed effects F Stat	2.00E+05 ***		8.70E+05 ***		59805.59 ***	
df	(18,116)		(18,116)		(18,116)	
Adj. R^2	0.8458		0.8517		0.8478	
Root MSE	0.4147		0.4000		0.4038	
AIC	2099.1		1865.5		1934.0	
Cumby-Huizinga Autocorrelation Test						
$\chi^2(4)$ Stat.	8.839 *		8.664 *		8.898 *	
Number of banks	117		117		117	
Number of observations	2038		1951		1981	
Dependent Variable	Agencies/Assets		Agencies/Assets		Agencies/Assets	
Estimation	FE DK SE lag=4		FE DK SE lag=4		FE DK SE lag=4	

Notes: Estimation method – fixed-effects with Driscoll-Kraay (1998) standard errors; MSE - Mean squared error; AIC – Akaike information criteria; all variables in logs but the standard deviations; estimates of coefficients associated with time and bank fixed effects are omitted; F Stat. is the statistic of the F-test of overall significance; $\chi^2(4)$ is the statistic of the Cumby-Huizinga test of serial correlation up to lag 4 with a null hypothesis of no serial correlation robust to within-cluster arbitrary correlation and between-cluster heteroskedasticity. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

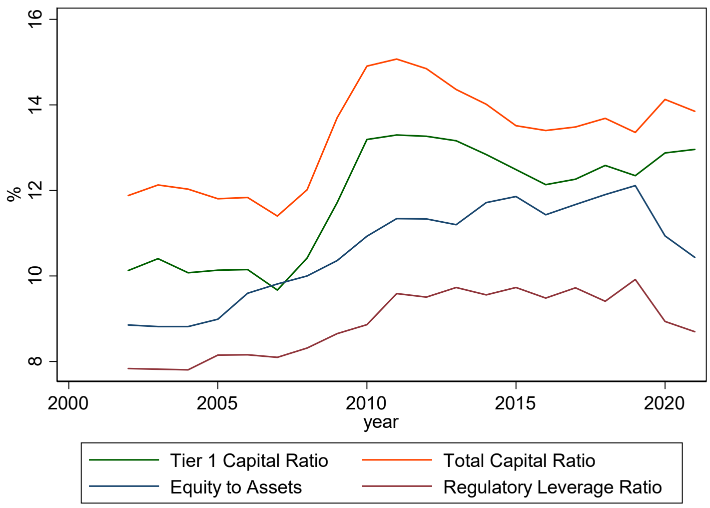

FIGURE A 3 - US ALTERNATIVE LEVERAGE MEASURES

Source: FFIEC. Author's calculations.

TABLE A XIII – US AGENCIES: ALTERNATIVE LEVERAGE MEASURES

Variables	Equity-to-assets		Leverage ratio		Total capital ratio		1st Quartile Equity-to-assets	
	Coef.	t Stat.	Coef.	t Stat.	Coef.	t Stat.	Coef.	t Stat.
Constant	-1.265 ***	-6.49	-1.314 ***	-7.62	-0.396 ***	-4.11	-1.281 ***	-5.88
Agencies to total assets (t-1)	0.732 ***	18.84	0.733 ***	18.72	0.734 ***	17.84	0.734 ***	18.86
Loan Rate spread over 30-year Mortgage	0.276 **	2.48	0.276 **	2.42	0.299 ***	2.73	0.268 **	2.30
Margin	-0.215 ***	-3.98	-0.214 ***	-3.77	-0.188 ***	-2.97	-0.216 ***	-3.96
NPL ratio	0.008	0.57	0.008	0.56	0.003	0.25	0.007	0.53
Leverage variable	-0.016	-0.20	0.007	0.08			-0.050	-1.00
Leverage variable (t-2)					-0.097	-1.54		
CB assets to total assets	0.006	0.90	0.006	1.06	0.002	0.42	0.007	1.11
CB assets to total assets * QE	-0.012 **	-2.12	-0.013 **	-2.17	-0.008	-1.22	-0.012 **	-2.06
GDP to potential GDP x Assets	-0.923 ***	-3.79	-0.920 ***	-3.88	-0.941 ***	-3.42	-0.919 ***	-3.79
Regional to National GDP growth rates x Assets	-0.001	-1.57	-0.001	-1.57	-0.001 *	-1.66	-0.001	-1.62
F Stat.	2236 ***		10750 ***		2118 ***		593 ***	
df	(102, 116)		(102, 116)		(102, 116)		(102, 116)	
No bank fixed effects F Stat	2.34 ***		2.34 ***		2.23 ***		2.36 ***	
df	(116,1765)		(116,1765)		(116,1667)		(116,1765)	
No time fixed effects F Stat	9.00E+05 ***		1.10E+06 ***		4.E+06 ***		1.10E+05 ***	
df	(18,116)		(18,116)		(17,116)		(18,116)	
Adj. R^2	0.8479		0.8479		0.8455		0.8481	
Root MSE	0.4037		0.4037		0.4039		0.4034	
AIC	1932.0		1932.1		1829.7		1929.2	
χ2(4) Stat.	8.718 *		8.885 *		9.783 **		9.126 *	
Number of banks	117		117		117		117	
Number of observations	1981		1981		1880		1981	
Dependent Variable	Agencies/Assets		Agencies/Assets		Agencies/Assets		Agencies/Assets	
Estimation	FE DK SE		FE DK SE		FE DK SE		FE DK SE	

Notes: Estimation method – fixed-effects with Driscoll-Kraay (1998) standard errors; MSE - Mean squared error; AIC – Akaike information criteria; all variables in logs but the standard deviations; estimates of coefficients associated with time and bank fixed effects are omitted; F Stat. is the statistic of the F-test of overall significance; χ2(4) is the statistic of the Cumby-Huizinga test of serial correlation up to lag 4 with a null hypothesis of no serial correlation robust to within-cluster arbitrary correlation and between-cluster heteroskedasticity. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

TABLE A XIV – US AGENCIES: ALTERNATIVE LOAN QUALITY MEASURES

Variables	Write-offs			Allowance Loan Losses		
	Coef.		t Stat.	Coef.		t Stat.
Constant	-0.580	***	-3.57	-0.724	***	-3.72
Agencies to total assets (t-1)	0.738	***	17.97	0.746	***	18.83
Loan Rate spread over 30-year Mortgage	0.240	**	2.18	0.242	**	2.02
Margin	-0.206	***	-3.91	-0.206	***	-3.61
Loan book quality variable	0.032	**	2.32	0.113	***	5.85
Debt-to-equity	-0.006		-0.09	0.032		0.41
CB assets to total assets	0.006		0.97	0.006		0.87
CB assets to total assets * QE	-0.013	**	-2.31	-0.012	*	-1.84
GDP to potential GDP x Assets	-0.851	***	-3.50	-0.755	***	-4.13
Regional to National GDP growth rates x Assets	-0.001		-1.65	-0.001		-1.53
F Stat.	5997	***		2860	***	
df	(102, 116)			(102, 116)		
No bank fixed effects F Stat	2.28	***		2.23	***	
df	(116,1756)			(116,1779)		
No time fixed effects F Stat	110000	***		1.40E+06	***	
df	(18,116)			(18,116)		
Adj. R^2	0.8487			0.8510		
Root MSE	0.4017			0.4041		
AIC	1902.2			1950.9		
$\chi^2(4)$ Stat.	9.654	**		7.808	*	
Number of banks	117			117		
Number of observations	1940			1995		
Dependent Variable	Agencies/Assets			Agencies/Assets		
Estimation	FE DK SE			FE DK SE		

Notes: Estimation method – fixed-effects with Driscoll-Kraay (1998) standard errors; MSE - Mean squared error; AIC – Akaike information criteria; all variables in logs but the standard deviations; estimates of coefficients associated with time and bank fixed effects are omitted; F Stat. is the statistic of the F-test of overall significance; χ2(4) is the statistic of the Cumby-Huizinga test of serial correlation up to lag 4 with a null hypothesis of no serial correlation robust to within-cluster arbitrary correlation and between-cluster heteroskedasticity. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

TABLE A XV - US AGENCIES MODEL SPECIFICATIONS WITH RISK VARIABLES

Variables	(7)			(8)			(9)		
	Coef.		t Stat.	Coef.		t Stat.	Coef.		t Stat.
Constant	-0.344		-0.36	-2.324	*	-1.87	-0.562		-0.55
Agencies to total assets (t-1)	0.749	***	19.84	0.733	***	18.70	0.748	***	20.27
Loan Rate spread over 30-year Mortgage	0.251	**	2.20	0.246	**	2.34	0.236	**	1.99
Margin	-0.206	***	-3.70	-0.192	***	-4.02	-0.216	***	-3.96
Allowance Loan Losses	0.104	***	5.44	0.112	***	4.96	0.112	***	5.12
Debt-to-equity	0.053		0.71	0.016		0.21	0.106		1.54
CB assets to total assets	0.005		0.86	0.002		0.33	0.005		0.87
CB assets to total assets * QE	-0.011		-1.55	-0.006		-0.77	-0.010		-1.42
GDP to potential GDP x Assets	-0.733	***	-4.21	-0.733	***	-3.87	-0.737	***	-4.51
Regional to National GDP growth rates x Assets	-0.001		-1.52	-0.001	*	-1.67	-0.001	*	-1.71
Income non-diversification (Interest Income/Total Income)(t-2)				0.079		1.25			
Std GDP to potencial GDP x Income diversification	4.903	***	4.10	4.887	***	4.29	5.065	***	4.55
Std deposit-to-assets x Mean Loan-to-Deposits	0.068		1.43	0.121	***	3.01	0.077		1.56
Std loan-to-assets x Mean loan-to-assets	-0.702		-1.27	-0.493		-0.97	-0.651		-1.14
Slowest asset growth banks							-0.048	**	-2.01
Worst capital position banks							-0.077		-1.67
F Stat.	7872	***		804	***		2629.51		
df	(104, 113)			(105, 113)			(106, 113)		
No bank fixed effects F Stat	2.07	***		2.12	***		2.10	***	
df	(113,1750)			(113,1650)			(113,1748)		
No time fixed effects F Stat	4.07E+04	***		1.00E+05	***		2.50E+06	***	
df	(18,113)			(17,113)			(18,113)		
Adj. R^2	0.8531			0.8477			0.8536		
Root MSE	0.4022			0.4044			0.4015		
AIC	1907.6			1824.0			1902.2		
$\chi^2(4)$ Stat.	7.433			9.766	**		7.768		
Number of banks	114			114			114		
Number of observations	1965			1863			1965		
Dependent Variable	Agencies/Assets			Agencies/Assets			Agencies/Assets		
Estimation	FE DK SE			FE DK SE			FE DK SE		

Notes: Estimation method – fixed-effects with Driscoll-Kraay (1998) standard errors; MSE - Mean squared error; AIC – Akaike information criteria; all variables in logs but the standard deviations; estimates of coefficients associated with time and bank fixed effects are omitted; F Stat. is the statistic of the F-test of overall significance; $\chi^2(4)$ is the statistic of the Cumby-Huizinga test of serial correlation up to lag 4 with a null hypothesis of no serial correlation robust to within-cluster arbitrary correlation and between-cluster heteroskedasticity. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

TABLE A XVI - IV ESTIMATOR DIAGNOSTICS UNDER ALTERNATIVE INSTRUMENTS

	Specifications using alternative instruments			
	(1)	(2)	(3)	(4)
	F Stat	**F Stat**	**F Stat**	**F Stat**
Instrumented Variables - Test on excluded instruments	df (3,113)	df (4,113)	df (5,113)	df (7,113)
Loan rate spread	4.52 ***	3.09 ***	23.02 ***	16.36 ***
Margin	58.16 ***	37.84 ***	99.25 ***	62.63 ***
Shea Partial R^2	0.0820	0.0727	0.1184	0.1223
Shea Partial R^2	0.5207	0.4687	0.5532	0.5351
Underidentification Test				
Ho: matrix of reduced form coefficients has rank = K1 -1 (underidentified)				
Ha: matrix has rank=K1 (identified)	$\chi^2(4)$ Stat.	$\chi^2(4)$ Stat.	$\chi^2(4)$ Stat.	$\chi^2(6)$ Stat.
Kleibergen-Paap rk LM statistic	12.36 **	10.03 **	38.87 ***	38.88 ***
Kleibergen-Paap rk Wald statistic	13.82 ***	12.42 ***	110.62 ***	62.63 ***
K1 = number endgenous regressors				
Weak identification Test				
Ho: equation is weakly identified				
Kleibergen-Paap Wald rk F statistic	4.500	3.027	21.561	16.117
10% maximal IV relative bias	8.78	7.56	8.78	9.92
10% maximal IV size	13.43	16.87	19.45	23.72
Tests of joint significance of endogenous regressors in main equation				
Ho: βs=0 and overidentifying restrictions are valid	$\chi2(3)$ Stat.	$\chi2(4)$ Stat.	$\chi2(5)$ Stat.	$\chi2(7)$ Stat.
Anderson-Rubin Wald test	7.54 *	8.63 *	4.92	16.74 **
Stock-Wright LM S statistic	5.58	6.75	3.98	10.40
Overidentification test of all instruments	$\chi^2(1)$	$\chi^2(2)$	$\chi^2(2)$	$\chi^2(2)$
Hansen J Stat.	2.132	3.466	1.92	7.249
(p-value)	0.1442	0.1767	0.5891	0.2028
Endogeneity Test				
Ho: instrumented variables can be treated as exogenous				
$\chi^2(2)$ Stat.	6.024 **	4.079	3.600	2.129

Notes: Estimation method – IV fixed-effects with cluster-robust standard errors. External instruments used: (1) – deposit rate and the ratio of general and administrative expenses to loans lagged once and twice; (2) – as in (1) but with up to three lags of the ratio of general and administrative expenses to loans; (3) as in (1) but with the twice lagged loan rate spread and margin; (4) – as in (3) but also with three times lagged loan rate spread and margin. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

Extended Treasuries

TABLE A XVII – EXT. TREASURIES HETEROSKEDASTICITY TESTS

H_0: constant variance of residuals			
Breusch-Pagan/Cook-Weisberg Test			
$\chi^2(1)$ Stat	p-value	F(1 , 1964)	p-value
9.5	0.0020	4.5	0.0340

H_0: equality of variances across banks					
Brown and ForsytheTest				Levene Test	
W50		W10		W0	
F(106 , 1859)	p-value	F(106 , 1859)	p-value	F(106 , 1859)	p-value
6.2838	0.0000	7.9668	0.0000	8.9344	0.0000

H_0: equality of variances across time (years)					
Brown and ForsytheTest				Levene Test	
W50		W10		W0	
F(19 , 1946)	p-value	F(19 , 1946)	p-value	F(19 , 1946)	p-value
0.7945	0.7161	0.8732	0.6174	1.0658	0.3807

Notes: Test on residuals from OLS regression of equation (1) over the period 2002-21 and 107 banks. The Levene test uses the mean (W0) as a measure of centre. Brown and Forsythe replace this measure with the median (W50) and with the 10% trimmed mean (W10). Conover, Johnson, and Johnson (1981) compare the properties of the mean and median tests and recommend using the median test for asymmetric data, as is the case of the US data. Source: author's calculations.

TABLE A XVIII – INITIAL EXT. TREASURIES MODEL SPECIFICATIONS

Variables	(1) Coef.		(1) t Stat.	(2) Coef.		(2) t Stat.	(3) Coef.		(3) t Stat.
Constant	-3.897	***	-8.07	-0.836	***	-3.19	-0.639		-0.73
Total Assets	0.854	***	37.08	0.829	***	4.12			
Ext. Treasuries to total assets (t-1)							0.672	***	10.74
Ext. Treasuries to total assets (t-2)									
Loan rate spread	0.888	***	7.80	0.086		1.14	-0.039		-0.24
Margin	-0.540	***	-6.70	-0.050		-0.88	-0.325	***	-4.06
NPL ratio	-0.139	***	-4.27	-0.011		-0.47	0.020		1.14
Debt-to-equity	0.809	***	6.26	0.163	**	2.23	0.274	*	1.77
GDP to potential GDP	-0.854		-0.36	-2.962		-1.12			
GDP to potential GDP x Assets							-0.422		-0.37
Regional to National GDP growth rates	0.011		0.52	0.011		1.02			
Regional to National GDP growth rates x Assets							0.001		0.23
Card Business Specialized Banks	-1.264	***	-5.67	-0.135		-0.87			
Foreign Banks	0.467	***	3.23	0.120		1.46			
State Member Banks	-0.358	***	-4.14	-0.001		-0.03			
State Savings Banks	-1.359	***	-5.04	-0.328	*	-1.81			
Ext. Treasuries (t-1)				0.854	***	26.40			
Assets (t-1)				-0.694	***	-3.67			
F Stat.	24	***		1583	***		3346.25	***	
df	(83, 1966)			(86, 106)			(99, 106)		
No bank fixed effects F Stat							2.30	***	
df							(106,1664)		
No time fixed effects F Stat							2.00E+05	***	
df							(18,106)		
Adj. R^2	0.4858			0.8601			0.7746		
Root MSE	1.5819			0.8146			0.7610		
AIC	7463.9			4465.8			4184.8		
Breusch-Pagan Heteroscedasticity Test									
$\chi2(1)$ Stat.	9.5	***							
Cumby-Huizinga Autocorrelation Test									
$\chi^2(4)$ Stat.	345.767	***		3.398			7.020 (1)		
Number of banks	107			107			107		
Number of observations	1966			1864			1864		
Dependent Variable	Ext.Treas.			Ext.Treas.			Treasuries/Assets		
Estimation	OLS			FE DK SE lag=4			FE DK SE lag=4		

Notes: DK SE - Driscoll-Kraay (1998) standard errors; FE – fixed-effects; MSE - Mean squared error; AIC – Akaike information criteria; all variables in logs; estimates of coefficients associated with time and bank fixed effects are omitted; F Stat. is the statistic of the F-test of overall significance; $\chi2(1)$ is the statistic of the Breusch-Pagan/Cook-Weiberg heteroskedasticity test with a null hypothesis of t = 0 in $Var(e_i)=\sigma^2 . exp(zt)$, where z is the fitted values; $\chi2(4)$ is the statistic of the Cumby-Huizinga test of serial correlation up to lag 4 with a null hypothesis of no serial correlation robust to within-cluster arbitrary correlation and between-cluster heteroskedasticity. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively. (1) Absence of serial correlation at lag 1 is rejected at 5%.

TABLE A XIX – EXT. TREASURIES MODEL SPECIFICATIONS WITH CENTRAL BANK ASSETS

Variables	(4)			(5)			(6)		
	Coef.		t Stat.	Coef.		t Stat.	Coef.		t Stat.
Constant	-0.501		-0.80	-0.508		-0.82	-0.842	*	-1.67
Ext. Treasuries to total assets (t-1)	0.669	***	11.27	0.668	***	11.26	0.774	***	15.25
Ext. Treasuries to total assets (t-2)							-0.098	***	-4.96
Loan rate spread	0.033		0.24	0.017	***	0.13	0.060		0.47
Margin	-0.352	***	-4.50	-0.349	***	-4.44	-0.266	***	-4.62
NPL ratio	0.021		1.22	0.021		1.24	0.015		0.81
Debt-to-equity	0.286	*	1.89	0.280	*	1.84	0.288	**	2.15
GDP to potential GDP x Assets	-0.166		-0.17	-0.239		-0.24	-0.636		-0.70
Regional to National GDP growth rates x Assets	0.001		1.33	0.001		1.33	0.001		1.06
CB assets to total assets	0.031	***	2.86	0.027	**	2.46	0.030	***	2.97
CB assets to total assets * QE	-0.084	***	-5.19	-0.079	***	-4.58	-0.062	***	-3.66
CB assets to total assets * Taper				0.044	*	1.79	0.044	**	2.22
F Stat.	4762.71	***		3809.55	***		1940.86	***	
df	(101, 106)			(102, 106)			(103, 106)		
No bank fixed effects F Stat	2.29	***		2.29	***		1.98	***	
df	(106,1628)			(106,1628)			(106,1524)		
No time fixed effects F Stat	89560.08	***		7.54E+04	***		1.10E+05	***	
df	(18,106)			(18,106)			(17,106)		
Adj. R^2	0.7789			0.7789			0.7899		
Root MSE	0.7537			0.7537			0.7339		
AIC	4073.0			4074.1			3745.5		
Cumby-Huizinga Autocorrelation Test									
$\chi^2(4)$ Stat.	5.860	(1)		5.935	(1)		1.297		
Number of banks	107			107			107		
Number of observations	1830			1830			1726		
Dependent Variable	Ext. Treas./Assets			Ext. Treas./Assets			Ext. Treas./Assets		
Estimation	FE DK SE lag=4			FE DK SE lag=4			FE DK SE lag=4		

Notes: DK SE - Driscoll-Kraay (1998) standard errors; FE – fixed-effects; MSE - Mean squared error; AIC – Akaike information criteria; all variables in logs; estimates of coefficients associated with time and bank fixed effects are omitted; F Stat. is the statistic of the F-test of overall significance; χ2(4) is the statistic of the Cumby-Huizinga test of serial correlation up to lag 4 with a null hypothesis of no serial correlation robust to within-cluster arbitrary correlation and between-cluster heteroskedasticity. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively. (1) Absence of serial correlation at lag 1 is rejected at 5%.

TABLE A XX – EXT. TREASURIES: ALTERNATIVE LEVERAGE MEASURES

Variables	Equity-to-assets			Leverage ratio			Tier 1 capital ratio			Total capital ratio		
	Coef.		t Stat.	Coef.		t Stat.	Coef.		t Stat.	Coef.		t Stat.
Constant	-			-			-0.303		-0.50	-		
Ext. Treasuries to total assets (t-1)	0.773	***	15.26	0.775	***	15.00	0.778	***	14.92	0.777	***	14.88
Ext. Treasuries to total assets (t-2)	-0.098	***	-4.99	-0.097	***	-4.81	-0.096	***	-4.78	-0.094	***	-4.68
Loan rate spread	0.068		0.54	0.075		0.63	0.046		0.38	0.090		0.71
Margin	-0.272	***	-4.68	-0.286	***	-4.39	-0.250	***	-3.68	-0.298	***	-4.43
NPL ratio	0.016		0.83	0.013		0.68	0.010		0.53	0.012		0.68
Leverage variable	-0.347	**	-2.23	-0.279		-1.51	0.044		0.44	-0.163		-1.61
GDP to potential GDP x Assets	-0.651		-0.73	-0.563		-0.55	-0.564		-0.56	0.001		-0.51
Regional to National GDP growth rates	0.001		1.05	0.001		1.08	0.001		1.10	0.001		1.09
CB assets to total assets	0.030	***	2.96	0.034	***	3.19	0.033	***	3.16	0.035	***	3.29
CB assets to total assets * QE	-0.062	***	-3.69	-0.063	***	-3.63	-0.062	***	-3.57	-0.062	***	-3.53
CB assets to total assets * Taper	0.044	**	2.22	0.048	**	2.29	0.051	**	2.38	0.052	**	2.38
F Stat.	784.63	***		1753.11	***		1328.01	***		3817.04	***	
df	(103, 106)			(103, 106)			(103, 106)			(103, 106)		
No bank fixed effects F Stat	1.99	***		1.95	***		1.97	***		1.97	***	
df	(106,1524)			(106,1524)			(106,1524)			(106,1524)		
No time fixed effects F Stat	3.22E+04	***		6.09E+04	***		2.12E+04	***		4.20E+04	***	
df	(17,106)			(17,106)			(17,106)			(17,106)		
Adj. R^2	0.7900			0.7895			0.7890			0.7891		
Root MSE	0.7337			0.7347			0.7355			0.7353		
AIC	3744.8			3749.5			3753.3			3752.2		
Cumby-Huizinga Autocorrelation Test												
$\chi^2(4)$ Stat.	1.285			1.200			1.532			1.634		
Number of banks	107			107			107			107		
Number of observations	1726			1726			1726			1726		
Dependent Variable	Ext. Treas./Assets			Ext. Treas./Assets			Ext. Treas./Assets			Ext. Treas./Assets		
Estimation	FE DK SE lag=4			FE DK SE lag=4			FE DK SE lag=4			FE DK SE lag=4		

Notes: DK SE - Driscoll-Kraay (1998) standard errors; FE – fixed-effects; MSE - Mean squared error; AIC – Akaike information criteria; all variables in logs; estimates of coefficients associated with time and bank fixed effects are omitted; F Stat. is the statistic of the F-test of overall significance; χ2(4) is the statistic of the Cumby-Huizinga test of serial correlation up to lag 4 with a null hypothesis of no serial correlation robust to within-cluster arbitrary correlation and between-cluster heteroskedasticity. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

TABLE A XXI – EXT. TREASURIES: ALTERNATIVE LOAN QUALITY MEASURES

Variables	Broad NPL ratio			Write-offs			Allowance Loan Losses		
	Coef.		t Stat.	Coef.		t Stat.	Coef.		t Stat.
Constant									
Ext. Treasuries to total assets (t-1)	0.773	***	15.24	0.753	***	13.91	0.767	***	14.89
Ext. Treasuries to total assets (t-2)	-0.098	***	-4.93	-0.084	***	-3.94	-0.091	***	-4.77
Loan rate spread	0.066		0.53	0.048		0.35	-0.071		-0.68
Margin	-0.268	***	-4.71	-0.234	***	-3.95	-0.253	***	-4.52
Loan book quality variable	0.008		0.26	0.020		0.87	0.273	***	5.68
Debt-to-equity	0.289	**	2.16	0.276	**	2.19	0.274	**	1.98
GDP to potential GDP x Assets	-0.649		-0.71	-0.639		-0.68	-0.196		-0.23
Regional to National GDP growth rat	0.001		1.05	0.001		1.04	0.001		1.22
CB assets to total assets	0.030	***	2.94	0.025	**	2.50	0.028	***	2.74
CB assets to total assets * QE	-0.062	***	-3.62	-0.056	***	-3.01	-0.056	***	-3.09
CB assets to total assets * Taper	0.045	**	2.22	0.057	***	2.92	0.039	*	1.94
F Stat.	2371.61	***		3483.64	***		7662.41	***	
df	(103, 106)			(103, 106)			(103, 106)		
No bank fixed effects F Stat	1.99	***		2.04	***		2.06	***	
df	(106,1528)			(106,1519)			(106,1536)		
No time fixed effects F Stat	7.82E+03	***		4.05E+04	***		3.49E+04	***	
df	(17,106)			(17,106)			(17,106)		
Adj. R^2	0.7902			0.7912			0.7929		
Root MSE	0.7332			0.7265			0.7293		
AIC	3751.2			3699.4			3750.7		
Cumby-Huizinga Autocorrelation Test									
$\chi^2(4)$ Stat.	1.218			1.225			1.602		
Number of banks	107			107			107		
Number of observations	1730			1721			1738		
Dependent Variable	Ext. Treas./Assets			Ext. Treas./Assets			Ext. Treas./Assets		
Estimation	FE DK SE lag=4			FE DK SE lag=4			FE DK SE lag=4		

Notes: DK SE - Driscoll-Kraay (1998) standard errors; FE – fixed-effects; MSE - Mean squared error; AIC – Akaike information criteria; all variables in logs; estimates of coefficients associated with time and bank fixed effects are omitted; F Stat. is the statistic of the F-test of overall significance; χ2(4) is the statistic of the Cumby-Huizinga test of serial correlation up to lag 4 with a null hypothesis of no serial correlation robust to within-cluster arbitrary correlation and between-cluster heteroskedasticity. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

TABLE A XXII – EXT. TREASURIES MODEL SPECIFICATIONS WITH RISK VARIABLES AND CAPITAL POSITION

Variables	(7)			(8)			(9)			(10)		
	Coef.		t Stat.	Coef.		t Stat.	Coef.		t Stat.	Coef.		t Stat.
Constant	-			2.086		0.84	-			-		
Ext. Treasuries to total assets (t-1)	0.771	***	15.03	0.769	***	15.31	0.766	***	15.17	0.766	***	15.12
Ext. Treasuries to total assets (t-2)	-0.097	***	-4.73	-0.096	***	-4.70	-0.096	***	-4.58	-0.096	***	-4.57
Margin	-0.285	***	-5.17	-0.293	***	-5.34	-0.226	***	-3.45	-0.229	***	-3.50
Allowances for loan Losses	0.274	***	6.82	0.276	***	7.30	0.283	***	6.96	0.279	***	6.79
Debt-to-equity	0.270	**	2.06	0.264	**	2.03	0.662	***	5.46	0.638	***	5.10
CB assets to total assets	0.030	***	3.18	0.028	***	2.82	0.026	***	2.84	0.026	***	2.81
CB assets to total assets * QE	-0.057	***	-2.94	-0.056	***	-3.24	-0.050	***	-2.53	-0.049	**	-2.46
CB assets to total assets * Taper	0.032	**	2.16	0.026	**	1.91	0.045	**	2.60	0.044	**	2.52
Std GDP to potencial GDP x Income non-diversification	2.804	***	2.81	4.193	***	2.75	2.619	**	2.59	2.648	**	2.56
Std deposit-to-assets x Mean Loan-to-Deposits				0.213	*	1.90						
Std loan-to-assets x Mean loan-to-assets				-1.542		-1.05						
Worst capital position banks							-0.255	***	-4.99			
Best capital position banks							0.191	***	4.35			
Worst capital position banks#Margin							-0.184	***	-3.43	-0.189	***	-3.47
Worst capital position banks#Debt-to-equity										-0.104	***	-4.47
Best capital position banks#Debt-to-equity										0.104	***	4.33
F Stat.	7074.7			1466.9			5113.9			4537.7		
df	(101, 104)			(103, 104)			(104, 104)			(104, 104)		
No bank fixed effects F Stat	2.04			2.01			2.13			2.10		
df	(104,1524)			(104,1522)			(104,1520)			(104,1521)		
No time fixed effects F Stat	3.09E+04			3.30E+05			5.53E+04			5.90E+04		
df	(17,104)			(17,104)			(17,104)			(17,104)		
Adj. R^2	0.7916			0.7917			0.7937			0.7934		
Root MSE	0.7287			0.7285			0.7250			0.7255		
AIC	3710.2			3711.4			3696.7			3697.9		
Cumby-Huizinga Autocorrelation Test												
$\chi^2(4)$ Stat.	1.396			1.344			1.808			1.315		
Number of banks	105			105			105			105		
Number of observations	1721			1721			1721			1721		
Dependent Variable	Ext. Treas./Assets			Ext. Treas./Assets			Ext. Treas./Assets			Ext. Treas./Assets		
Estimation	FE DK SE lag=4			FE DK SE lag=4			FE DK SE lag=4			FE DK SE lag=4		

Notes: DK SE - Driscoll-Kraay (1998) standard errors; FE – fixed-effects; MSE - Mean squared error; AIC – Akaike information criteria; all variables in logs; estimates of coefficients associated with time and bank fixed effects are omitted; F Stat. is the statistic of the F-test of overall significance; χ2(4) is the statistic of the Cumby-Huizinga test of serial correlation up to lag 4 with a null hypothesis of no serial correlation robust to within-cluster arbitrary correlation and between-cluster heteroskedasticity. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

TABLE A XXIII – IV ESTIMATOR DIAGNOSTICS UNDER ALTERNATIVE INSTRUMENTS

	Specifications using alternative instruments				
	(1)	(2)	(3)	(4)	(5)
Instrumented Variables - Test on excluded instruments					
F Stat	36.92 ***	81.44 ***	47.22 ***	87.27 ***	170.74 ***
df	(4,104)	(2,104)	(2,104)	(4,104)	(3,104)
Shea Partial R^2	0.4069	0.4464	0.4186	0.4926	0.5208
Underidentification Test					
Ho: matrix of reduced form coefficients has rank = K1 -1 (underidentified)					
Ha: matrix has rank=K1 (identified)	$\chi^2(4)$ Stat.	$\chi^2(2)$ Stat.	$\chi^2(2)$ Stat.	$\chi^2(4)$ Stat.	$\chi^2(4)$ Stat.
Kleibergen-Paap rk LM statistic	14.72 **	12.28 ***	11.56 ***	21.21 ***	17.89 ***
Kleibergen-Paap rk Wald statistic	151.93 ***	167.26 ***	97.00 ***	359.07 ***	526.33 ***
K1 = number endgenous regressors					
Weak identification Test					
Ho: equation is weakly identified					
Kleibergen-Paap Wald rk F statistic	36.925 **	81.436 **	47.220 *	87.274 **	170.742 **
10% maximal IV relative bias	10.27	-	-	10.27	9.08
10% maximal IV size	24.58	19.93	19.93	24.58	22.3
Weak-instrument-robust inference					
Tests of joint significance of endogenous regressors in main equation					
Ho: β=0 and overidentifying restrictions are valid	$\chi2(4)$ Stat.	$\chi2(3)$ Stat.	$\chi2(5)$ Stat.	$\chi2(7)$ Stat.	$\chi2(7)$ Stat.
Anderson-Rubin Wald test	3.54	1.03	1.75	3.98	5.20
Stock-Wright LM S statistic	2.87	0.85	1.55	2.97	3.85
Overidentification test of all instruments	$\chi^2(2)$	$\chi^2(1)$	$\chi^2(2)$	$\chi^2(2)$	$\chi^2(2)$
Hansen J Stat.	2.727	0.856	1.193	2.366	2.771
(p-value)	0.4357	0.3549	0.2747	0.5000	0.2502
Endogeneity Test					
Ho: instrumented variables can be treated as exogenous					
$\chi^2(1)$ Stat.	0.846	2.836 *	0.273	0.795	1.011

Notes: Variable instrumented: margin. Estimation method – IV fixed-effects with cluster-robust standard errors. External instruments used: (1) – deposit rate and the ratio of general and administrative expenses to loans lagged up to three times; (2) – ratio of general and administrative expenses to loans lagged up to two times; (3) as in (1) but with only one lag of the ratio of general and administrative expenses to loans; (4) as in (2) but also with the margin lagged two and three times; (5) – as in (4) but with the margin lagged only two times. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

TABLE A XXIV - Ext. Treasuries Fixed Effects Bias Correction with CSD

Variables	(11) Coef.		(11) t Stat.	(12) Coef.		(12) t Stat.	(13) Coef.		(13) t Stat.	(14) Coef.		(14) t Stat.
Constant	-			-			-			-		
Ext. Treasuries to total assets (t-1)	0.761	***	15.52	0.843	***	14.35	0.886	***	15.96	0.877	***	17.98
Ext. Treasuries to total assets (t-2)	-0.095	***	-4.72	-0.050		-1.60	-0.081	**	-2.09	-0.079	**	-2.05
Margin	-0.203	***	-3.00	-0.212	*	-1.82	-0.106		-0.69	-0.094		-0.62
Allowances for loan Losses	0.260	***	9.13	0.240	***	2.80	0.194	**	2.23	0.191	**	2.37
Debt-to-equity	0.662	***	5.51	0.598	***	3.73	0.618	***	3.24	0.627	***	3.12
CB assets to total assets	0.026	***	3.07	0.031		1.55	0.003		0.15	0.003		0.19
CB assets to total assets * QE	-0.045	**	-2.26	-0.053	*	-1.76	-0.012		-0.46	-0.014		-0.56
CB assets to total assets * Taper	0.054	***	2.85	0.042		1.15	0.090	**	2.06	0.086	*	1.82
Std GDP to potencial GDP x Income non-diversification	2.743	**	2.52	3.360		0.75	-0.357		-0.12	-0.916		-0.29
Worst capital position banks#Margin	-0.191	***	-3.63	-0.171		-1.39	-0.139		-0.90	-0.138		-1.16
Worst capital position banks#Debt-to-equity	-0.110	***	-5.06	-0.104	***	-2.76	-0.093	**	-2.36	-0.092	**	-2.51
Best capital position banks#Debt-to-equity	0.113	***	5.52	0.119	***	3.64	0.106	**	2.19	0.104	**	2.25
F Stat.	90511.0	***										
df	(31, 104)											
No bank fixed effects F Stat	2.09	***										
df	(104,1587)											
No time fixed effects F Stat	5.48E+04	***										
df	(17,104)											
Adj. R^2	0.7937											
Root MSE	0.7406											
AIC	3768.8											
Cumby-Huizinga Autocorrelation Test												
$\chi^2(4)$ Stat.	2.621											
Number of banks	105			105			68			68		
Number of observations	1721			1683			1224			1224		
Dependent Variable	Ext. Treas./Assets			Ext. Treas./Assets			Ext. Treas./Assets			Ext. Treas./Assets		
Estimation	FE DK SE lag=4			BCFE BS SE CSHET			BCFE BS SE CSD			BCFE BS SE CSHET		

Notes: DK SE - Driscoll-Kraay (1998) standard errors; FE – fixed-effects; BCFE BS SE CSHET –Bootstrap-corrected fixed-effects estimator for dynamic panel-data models of general AR order (p). The estimator corrects the small T Nickell (1981) bias using a simplified but extended version of the approach presented in Everaert and Pozzi (2007) of an algorithm that evaluates the bias of fixed effects in a numerical way to avoid the use of analytical correction formulas, allowing for several heteroskedasticity and cross-sectional dependence patterns through the choice of resampling schemes. CSHET – Cross-section heteroskedasticity indicating that error terms are resampled within cross-sections. CSD - Cross-Sectional Dependence, specifying that time indices are resampled identically for all cross-sections, while keeping error terms cross-section specific. It requires strongly balanced panels. MSE - Mean squared error; AIC – Akaike information criteria; all variables in logs; estimates of coefficients associated with time and bank fixed effects are omitted; F Stat. is the statistic of the F-test of overall significance; $\chi2(4)$ is the statistic of the Cumby-Huizinga test of serial correlation up to lag 4 with a null hypothesis of no serial correlation robust to within-cluster arbitrary correlation and between-cluster heteroskedasticity. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.

TABLE A XXV – EXT. TREASURIES DPD SYSTEM GMM ESTIMATES OVER SUB-SAMPLES

Variables	(2)		(4) 2008-15		(5) Nat & SMB		(6) NMB	
	Coef.	z Stat	Coef.	z Stat	Coef.	z Stat	Coef.	z Stat
Constant	-0.727 **	-2.46	-3.011 *	-1.78	-2.681 *	-1.66	-0.617 **	-2.01
Treasuries to total assets (t-1)	0.894 ***	15.25	0.879 ***	14.78	0.872 ***	12.10	0.966 ***	10.56
Treasuries to total assets (t-2)	-0.056	-1.32	-0.144 ***	-4.25	-0.053	-1.12	-0.082 **	-2.10
Margin	-0.009	-0.12	0.044	0.43	0.004	0.04	-0.117 *	-1.66
Allowances for loan Losses	0.107 ***	2.61	0.102 *	1.65	0.119 **	1.99	0.130 ***	2.75
Debt-to-equity	0.420 **	2.48	0.921 ***	3.83	0.491 **	2.51	0.246 *	1.66
CB assets to total assets	0.011	0.72	0.033 *	1.70	0.047 *	1.74	-0.032 ***	-2.61
CB assets to total assets * QE	-0.019	-0.73	-0.064 **	-2.35	-0.041	-1.10	0.026	1.13
CB assets to total assets * Taper	0.028	0.81			0.001	0.01	0.071	1.58
Std GDP to potencial GDP x Income non-diversification	3.895	1.01	5.098	0.71	4.786	1.06	6.328	1.12
Worst capital position banks#Margin	-0.162 **	-2.28	-0.298 ***	-2.66	-0.198 **	-2.28	0.069	0.35
Worst capital position banks#Debt-to-equity	-0.068 **	-2.25	-0.157 ***	-3.49	-0.082 ***	-2.71	-0.034	-0.81
Best capital position banks#Debt-to-equity	0.073 **	2.40	0.097 *	1.81	0.093 **	2.27	0.059 *	1.74
Wald χ2	3602 ***		2.E+03 ***		3.E+03 ***		4.E+04 ***	
df	29		18		29		29	
Arellano-Bond test for AR(2) in first differences (p-value)	0.370		0.880		0.809		0.923	
Hansen J test of over-identifying restrictions (p-value)	0.224		0.169		0.360		0.677	
Number instruments	34		28		34		34	
Number of banks	105		104		66		34	
Number of observations	1721		761		1102		560	
Period			2008-15					
Lags instrumenting lagged dependent variable	(1 3)		(1 3)		(1 3)		(1 3)	

Notes: Estimation method – System GMM with forward orthogonal deviations and collapsed instruments on the lagged dependent variable. No external instruments are used. Bank event dummies have been removed. The asterisks ***, **, * indicate significance at the 1%, 5%, and 10% level, respectively.