

# How Banks Can Amend Their Balance Sheets In Order To Comply With The Net Stable Funding Ratio

*An Investigation of the Balance Sheet Drivers of the Net Stable Funding Ratio*

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# Resumé

Formålet med denne afhandling er at undersøge hvilke balanceopgørelsesmæssige tilpasningsstrategier store, kommercielle banker kan benytte for at imødekomme NSFR likviditetskravet i den kommende Basel III regulering.<sup>1</sup> Nærmere bestemt har vi undersøgt hvilke specifikke balanceopgørelsesposter der har vist sig at være signifikante determinanter for bankernes årlige NSFR ændringer. Denne undersøgelse er baseret på et sæt af 8 hypoteser angående bankers forventede tilpasningsadfærd. Hypoteserne er konstrueret på baggrund af velunderbyggede mistanker fra respekterede markedsaktører angående justeringer af de undersøgte balanceopgørelsesposter. Gennem test af de 8 hypoteser for bankers tilpasningsadfærd vil vi besvare følgende spørgsmål.

*Hvordan kan banker justere deres balanceopgørelser for at imødekomme NSFR kravet?*

Vi har udført analysen på en stikprøve bestående af de 161 største kommercielle banker i USA baseret på detaljeret balanceopgørelsesdata fra FFIEC<sup>2</sup> Call Reports. I den første del af analysen har vi testet de 8 hypoteser angående bankers tilpasningsadfærd ved hjælp af panel data regressioner over et tidsspænd fra 2009 til 2014. I den anden del af analysen har vi opsat en matching procedure med henblik på at undersøge hvorvidt regressionsresultaterne kan matche NSFR-motiveret bankadfærd.

Som en integreret del af vores undersøgelse af bankers tilpasningsadfærd i forhold til NSFR kravet, har denne afhandling bidraget på tre områder. Som det første har vi beregnet NSFR for 6750 kommercielle, amerikanske banker, og af disse har vi benyttet de 161 største af bankerne til hypotesetest ved hjælp af panel data regressioner. Vores NSFR beregninger viser, at de største kommercielle banker i USA ligger forholdsvist tæt omkring NSFR kravet på 100% allerede i 2009. En udviklingsanalyse over tid viser at fordelingen omkring NSFR kravet bliver mærkbart smallere i form af aftagende standardafvigelse og skævhed fra 2009 til 2014. Disse observationer fortæller at der allerede fra 2009 har været tydelige ændringer i bankernes NSFR, og at banker der i 2009 lå over NSFR kravet på 100% har nedjusteret deres NSFR frem mod 2014.

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<sup>1</sup> Basel III's tredje søjle udgøres af en række likviditetskrav til banker. Blandt disse likviditetskrav findes NSFR. Kravet for NSFR er formuleret som at banker til enhver tid skal have en NSFR på mindst 1.

<sup>2</sup> FFIEC (Federal Financial Institutions Examination Council) er et kombineret organ der udsteder uniforme principper og standarder til en lang række finansielle og regulatoriske institutioner, deriblandt Board of Governors of the Federal Reserve System (FRB), Federal Deposit Insurance Corporation (FDIC), National Credit Union Administration (NCUA), Office of the Comptroller of the Currency (OCC).

Som det andet har vi fundet et specifikt sæt af balanceopgørelsesposter der har vist sig at være signifikante determinanter for store, kommercielle bankers årlige NSFR ændringer. I forlængelse af disse resultater viste matching proceduren, at størstedelen af determinanterne bliver justeret på en måde der ligger i tråd med NSFR-motiveret tilpasning. Dette indikerer at bankerne potentielt set benytter disse balanceopgørelsesposter som et værktøj i forbindelse med NSFR tilpasning.

Som det tredje har vi bidraget med et fundament til videre undersøgelser. Vi har bidraget med materiale i form af et stort datasæt der indeholder 6570 amerikanske kommercielle banker for hvilke vi har målt på 334 forskellige variable gennem seks sammenhængende år fra 2009 til 2014.

Resultatet af vores undersøgelse er et sæt af værktøjer, som store kommercielle banker potentielt benytter til at justere deres NSFR. Dette sæt af værktøjer er baseret på NSFR ændringer der har udvist signifikante lineære relationer til de specifikke balanceopgørelsesposter. Mere specifikt, har vi fundet seks tilpasningsværktøjer som bankerne kan bruge til NSFR-justering.

- i) Banker kan nedjustere deres andel af deres totale aktiver der udgøres af høj-risiko instrumenter<sup>3</sup>.*
- ii) Banker kan øge deres andel af totale passiver der udgøres af langsigtede depoter<sup>4</sup>.*
- iii) Banker kan nedjustere deres andel af totale aktiver der udgøres af derivatprodukter.*
- iv) Banker kan øge deres andel af totale aktiver der udgøres af High-Quality Liquid Assets<sup>5</sup>.*
- v) Banker kan nedjustere deres andel af totale aktiver der udgøres af udlån<sup>6</sup>.*
- vi) Banker kan nedjustere deres andel af totale aktiver der udgøres af 100% risikovægtede udlån.*

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<sup>3</sup> Høj-risiko instrumenter, også kaldet høj-risiko securities, er de typer af instrumenter der er tildelt 50% eller 100% risikovægtninger i forhold til Basel II Standardized Approach for credit risk.

<sup>4</sup> Langsigtede depoter figurerer som long-term time deposits i de Call Reports der er hentet fra FFIEC's database.

<sup>5</sup> HQLA består af en banks kontanter samt securitites og reverse repos der er blevet tildelt risikovægte på 0% eller 20% der er tildelt 50% eller 100% risikovægtninger i forhold til Basel II Standardized Approach for credit risk.

<sup>6</sup> Udlån er her en oversættelse af total lending fra de Call Reports der er hentet fra FFIEC's database.

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# 1. Introduction

The global financial crisis of 2007 and 2008 exposed several shortcomings and issues in the management of market liquidity and funding risk for individual banks. These issues had significant negative effects for the overall system-wide financial stability. The asset and liability structures of banks proved to be very vulnerable to shocks in the market, as well as to bank runs from investors and breakdowns in the wholesale funding markets. These vulnerabilities partly showed banks' steadily increasing reliance on short-term wholesale funding as a way to make their balance sheets grow over the past 20 years. In general, banks were relying less on their own capital raising efforts and traditional monetary liabilities, such as insured and non-insured deposits. At the same time, they were investing increasingly more of these borrowed wholesale-funds in assets that turned out to be very illiquid. Most of the global banks had relatively elaborate frameworks in place regarding their management of liquidity risk. These frameworks included frequent stress testing of the market liquidity, international loan to deposit limits, and a large range of additional indicators. These indicators were typically ratios of marked sourced funding to managed assets, short-term funds dependence and stable assets to stable funding. The general issue for these frameworks was a lack of consistent application across the banking group. When the crisis struck, it was clear that many banks were exposed to hidden liquidity risks in their balance sheets. Many assets that appeared liquid under normal market circumstances turned out to become illiquid once the market conditions turned sour.

As a response to this, regulators have increased their efforts in order to control and limit the excessive liquidity risk exposures of the banking sector. As a part of the Basel III framework, the Basel Committee on Banking Supervision issued two new quantitative liquidity standards in December 2010<sup>1</sup>. These were the Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR). This was the first time in history that the Basel Committee on Banking Supervision was requiring liquidity risk standards to be implemented consistently across jurisdictions. The LCR framework was completed in 2013 and requires a given bank to hold sufficient high-quality liquid assets to overcome a liquidity stress of at least 30 calendar days. The LCR thereby promotes the use of high-quality liquid assets in order to ensure short-term liquidity resilience. This should enable banks to survive a significant funding stress scenario for 30 calendar days, which is defined as a

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<sup>1</sup> Basel Committee on Banking Supervision, *Basel III: A global regulatory framework for more resilient banks and banking systems*, Bank for International Settlement (BIS), [www.bis.org](http://www.bis.org), December 2010.

situation where banks cannot obtain liabilities such as client deposits, central bank lending, or issue bonds in order to finance their assets.<sup>2</sup> The Basel III reform focus has now shifted towards finalizing the calibration of the Net Stable Funding Ratio and evaluating its impact onto the banking sector. The NSFR is intended to limit the maturity transformation risk in the banking sector by promoting more stable funding sources and asset liquidity. Additionally, it is also intended to be a long-term supplement to the LCR by addressing the funding risk within a one-year time horizon. It promotes a conservative funding structure relative to the composition of assets and off-balance sheet activities. A conservative structure stimulates more stable and longer-term liabilities as well as a liquid and flexible asset composition. This is intended to increase the amount of available liquid funding and decrease the amount of illiquid assets which will result in a reduction in the liquidity risk of banks.<sup>3</sup>

However, the calculation methodology of the NSFR is complicated when compared to other transformation risk measures such as e.g. loan to deposits ratios. In addition to this, there does not exist agreement of whether the weighting methodology of asset and liability items reflects appropriate liquidity risk assumptions. In the light of these concerns it is difficult to predict how the NSFR will impact the banking system. Furthermore, it will be interesting to see how banks can and will adjust their balance sheets towards compliance with the NSFR requirement.

## 1.1 Problem Statement and Research Focus

As of now, the implications of the NSFR implementation are still uncertain. As a part of this uncertainty, it has not yet been investigated how banks will accommodate for the NSFR requirement before its full implementation in January 2018.

The NSFR will impose additional costs onto banks in several ways. First of all, the stable funding required to cover the possible risks hidden on the asset side of a bank's balance sheet comes at a significant price. Obtaining NSFR relevant funding requires banks to rely heavily on long-term and stable funding which is expensive and will increase the average cost of capital. Second, the reduction in risky assets promoted by the NSFR in exchange for asset classes of lower risk will have large consequences for the banks. The reallocation towards less risky assets will have a

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<sup>2</sup> Basel Committee on Banking Supervision, Basel III, *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, January 2013, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), Page 1.

<sup>3</sup> Basel Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), October 2014, Page 1.



negative impact on the profitability and return received from marketed banking products. In a standard risk return setting, risk correlates positively with return. This means that an asset composition of average lower risk will make it more difficult to maintain a sufficient return on investment. In this way, the implementation of the NSFR is increasing the funding costs while also squeezing the return of marketed banking products. How banks might respond to this is an open question. However, according to the NSFR calculation methodology certain balance sheet adjustments seems more feasible than others in order to meet the NSFR target before January 2018.

When the banks are going to increase the amount of available stable funding and decrease their holdings of risky assets they will have to take account of three different factors. The additional costs from the adjustment, the speed of implementation and whether a particular balance sheet adjustment fits to the bank's overall business strategy. In this way, a bank's choice of which balance sheet items to adjust will rely on a prioritization of the above factors. As will be outlined in section 2, the NSFR calculation methodology assigns different weighting factors to the different balance sheet items that are included in the NSFR calculation. Thereby, certain balance sheet items will be more relevant for NSFR adjustments than others. In combination with the above priorities, banks are then facing a rather complex optimization problem when they want to adjust their NSFRs.

How banks can and will adjust their balance sheets towards the NSFR requirement remains an unanswered question. Analyzing balance sheet items as potential significant drivers of changes in the NSFR will indicate which asset and liabilities banks might actually be using for NSFR compliance. Such an analysis can uncover the historical balance sheet adjustments of banks and provide a set of balance sheet items that can be used for future NSFR accommodation strategies. However, we cannot establish direct causality due to the existence of multiple regulatory requirements and other bank specific objectives that might also drive balance sheet adjustments. Instead, an econometrical analysis can reveal if the adjustments are made in a significant relation towards the changes in the NSFR. Evaluating the sign and significance on estimated parameters will at least provide an indication of which balance sheet items that might be a used-in-practice tool<sup>4</sup> for NSFR compliance of the banks.

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<sup>4</sup> We will use the term *used-in-practice tool* in order to denote a balance sheet item that has shown to be a potentially relevant item for NSFR adjustments. Thereby, the term *used-in-practice tool* will be applied to balance sheet items that has shown precedent adjustments that have been significantly associated with changes in a bank's NSFR. This will be elaborated on as a part of the hypotheses testing in section 7.

In order to investigate how banks can react to the introduction of the NSFR, we will test which balance sheet items that are significant drivers of the yearly changes in their NSFRs. Specifically, we will try to answer the following question.

*How can banks adjust their balance sheets in order to comply with the NSFR?*

In order to answer this question we have constructed a number of hypotheses regarding potential NSFR-relevant balance sheet adjustments. The goal is then to test and evaluate these hypotheses by using regression analysis. In addition to our own thoughts on what banks might do, some of these hypotheses builds on suspicions from internationally recognized consultancies and academic scholars. Section 3.2 will provide an elaborated explanation on these hypotheses and their rationales.

### 1.3 Delimitation

The financial regulation outlined in the Basel III is a complicated and technical area. The development of guidance and regulation is based on numerous years of research and advice from leading scholars, experts, and government affiliates. The possible areas of investigation are therefore endless. For this reason, we will have to make a number of delimitations in order to establish a sensible focus for our investigation.

Since the NSFR was announced in 2010, there has been a large amount of debate on its construction between academic scholars and practioners. This debate has covered the appropriateness of the available stable funding and required stable funding components, as well as the weighting methodology applied in calculating the NSFR. Practioners have argued that the consequences for banks from implementing the NSFR should be reduced. Academic scholars have had a rather ambiguous view on the construction, depending on the given research aim. We will not engage in the discussion of how the NSFR should be constructed, neither will we debate its sub-components or weighting methodology. Instead, we provide a detailed overview of the NSFR calculation methodology. In addition to this, we also highlight the changes that were made from the initially proposed version as of December 2010 to the reviewed and final version as of October 2014.

A number of academic scholars and practitioners have also debated the implications for the overall economy. We do not take part in this debate, but provide a high-level overview of studies that have calculated the NSFR in assessing these implications.

Empirical NSFR research has been limited due to the recent announcement of the requirement as well as the complexity of the NSFR calculation methodology. Calculating the exact NSFR requires very granular balance sheet data segmented across risk-categories, maturities and counterparty types. Such granular data is not disclosed by banks. Therefore, it is not possible to make exact calculations of the NSFR for any particular bank. However, we can rely on publicly available data sources that allow for a close approximation of the measure. The goal of this thesis is not to analyze the development of the exact NSFR for banks. Instead, we want to identify which balance sheet items that are significant drivers of changes in the NSFR and whether this association is truly NSFR relevant.

As a final note, the investigation of banks' balance sheet adjustments towards the NSFR requirement will make it necessary to apply a number of statistical concepts. These statistical tools will serve an applied and practical purpose. A mathematical derivation and understanding of these are therefore outside the focus of the thesis. Derivations and statistical theory will only be present if they ease the understanding for certain choices or findings.

## 2. The Net Stable Funding Ratio

The following section provides an overview and understanding of the NSFR. We will outline the overall purpose of the NSFR and provide a detailed description of the calculation methodology. The concepts explained in this section will be used extensively in the analysis part of the thesis.

### 2.1 The Motivations Behind the NSFR

The Net Stable Funding Ratio is intended to work as a global maturity transformation risk measure that aims to limit banks' reliance on short-term funding. The NSFR calculation is supposed to capture the fraction of a bank's assets that are categorized as less liquid and which are funded by short-term funding types within a one-year time horizon. Thereby, the NSFR stimulates stable bank funding in a one-year time-horizon and is intended to supplement the short-term 30-day time-horizon of the Liquidity Coverage Ratio. The NSFR promotes a sustainable liquidity profile of banks by ensuring that available liquid funding resources meet the required funding needs. On a bank-specific level, a sustainable liquidity profile should make it possible for banks to survive periods of funding disruption. On the banking-sector level, the NSFR should lower the risk of systemic distress. This is important in maintaining a healthy world-economy and lowering the needs for government interventions.

The liquidity shortcomings seen in financial markets are a function of the maturity transformation of banks. Banks' transactions of assets and liabilities of different maturities contribute towards an efficient allocation of resources in the society. This is done by matching the various needs for deposits and loans across clients. However, it also represents a liquidity risk for the banks. This liquidity risk was exposed during the financial crisis. Maturity transformation risk can arise if illiquid long-term assets are funded by relatively liquid short-term liabilities. Specifically, this risk arises as new or extended liabilities will have to fund long-term assets at the maturity of the current liabilities.

The incentives to limit the reliance on such unstable funding have historically been weak. This has made it possible for banks to grow their balance sheets while relying on cheap and abundant short-term wholesale funding. This funding trend has increased the vulnerability of banks' balance sheets

and weakened the ability to respond to funding disruptions. In a highly interconnected world, this lead to systemic implications as seen during the 2007-08 financial crisis.<sup>5</sup>

As a response to the weak liquidity risk management principles in the banking sector the Basel Committee have published the “Principles for Sound Liquidity Risk Management and Supervision”. These *Sound Principles*<sup>6</sup> was published in 2008 and serve as a foundation for the Committee’s liquidity risk management framework. This framework provides comprehensive guidance on the management of funding risk and is intended to improve the risk management abilities of banks. The Committee is supervising the adoption of the principles to ensure adherence among banks across all participating jurisdictions.<sup>7</sup> In addition to these principles, the Committee has developed the NSFR and the LCR as two criteria for funding and liquidity management.

In addition to the LCR and the NSFR, the Committee has also developed a range of liquidity risk monitoring tools in order to measure other dimensions of a bank’s liquidity risk profile. These are used to ensure an identical global approach in the supervision of liquidity risk. The exact measures however, are only meant to serve as supplementary instruments to the LCR and the NSFR. These liquidity risk monitoring tools capture specific information in relation to contractual maturity mismatches, concentration of funding, available unencumbered collateral and certain market indicators.<sup>8</sup>

As a result of the possible consequences of implementing the NSFR, the Basel Committee decided to conduct a review of the NSFR during an observation period. This review was meant to address possible unintended consequences for the functioning of financial markets and improve the NSFR construction with respect to a number of key issues. One of these issues has been the impact on retail business activities. The NSFR will limit the traditional role of banks in providing market liquidity and maturity transformation. This could lead to a long-term lending shortage and depressed economic growth. Second, several practitioners fear that many deposits will become

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<sup>5</sup> Basel Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), October 2014, Page 1.

<sup>6</sup> The notation for the “Principles for Sound Liquidity Risk Management and Supervision” adopted from the Basel Committee on Banking Supervision.

<sup>7</sup> A full list of all member jurisdictions can be seen on [http://www.bis.org/about/member\\_cb.htm?m=1%7C2%7C601](http://www.bis.org/about/member_cb.htm?m=1%7C2%7C601)

<sup>8</sup> Basel Committee on Banking Supervision, Basel III: *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), January 2013, page 2.

more unstable due to an increasing deposit hunt among banks. Third, the NSFR might increase the incentives to move maturity transformation activities to the off-balance sheet sector.<sup>9</sup>

Based on this review, the Basel Committee published a slightly modified NSFR in October 2014. The structure and intention of the NSFR remained unchanged, but small adjustments were made to the NSFR weighting scheme. These adjustments will be explained in section 2.5 on changes to the NSFR calculation methodology.

## 2.2 Definition and Implementation of the NSFR

The NSFR is calculated as the amount of “available stable funding” (ASF) relative to the amount of “required stable funding” (RSF), and is required to be at least equal to 1 at all times in order to ensure a sound liquidity risk profile within a one-year horizon. An NSFR level equal to, or greater than 1 will ensure that banks have enough available funding relative to required funding, and will thereby limit the risk of a liquidity dry-up.<sup>10</sup>

ASF is defined as the capital and liabilities that are expected to be available during the time-horizon of the NSFR. The RSF component is defined as the capital and liabilities that are required to be available during the time-horizon of the NSFR. The amount of available stable funding depends on the liability composition of a given bank. The specific liability category and source is important in assessing the amount of available stable funding. The amount of required stable funding is a function of bank-specific liquidity and residual maturities of the bank’s assets and off-balance sheet exposures. If the illiquidity or the maturity of a bank’s asset composition increases, this will increase the amount of required stable funding.<sup>11</sup>

$$\text{NSFR} = \frac{\text{ASF}}{\text{RSF}}$$

The NSFR is designed upon internationally agreed definitions that addresses concrete issues faced by countries that are represented in the Basel Committee. However, the NSFR is subject to national discretion. This is intended to reflect different conditions and ambitions across jurisdictions covered

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<sup>9</sup> Gobat, Jeanne; Yanase, Mamoru; Maloney, Joseph, *The Net Stable Funding Ratio: Impact and Issues for Consideration*, IMF Working Paper, June 2014, page 3.

<sup>10</sup> Banking Committee on Banking Supervision, *Basel III: The Net Stable Funding Ratio*, Bank for International Settlements (BIS), www.bis.org, October 2014, Page 2.

<sup>11</sup> Banking Committee on Banking Supervision, *Basel III: The Net Stable Funding Ratio*, Bank for International Settlements (BIS), www.bis.org, October 2014, Page 2.

by the NSFR.<sup>12</sup> Denmark, being a part of the European Union, is following the EU adoption of the standard outlined in the “Capital Requirement Directive IV” (CRD IV). Following an investigation by the European Banking Authority, a final implementation plan is expected in the end of 2016.<sup>13</sup> The CRD IV replaces the former CRD with a new regulatory framework based upon Basel III. This new regulatory framework includes the NSFR. Significant adjustments from the Basel III regulation have not been introduced into CRD IV since the EU has actively participated in the regulatory development. The EU has however tightened legislation around variable remuneration, board governance and diversity, as well as transparency regarding the activities of banks.<sup>14</sup> For the U.S, it is still unclear when the regulators will adapt to the NSFR. The Federal Reserve has indicated that the U.S. will have a final implementation plan ready as of year-end 2015. This is one year ahead of the European Union. This implementation pattern is similar to that of the Liquidity Coverage Ratio. In the U.S. the Liquidity Coverage Ratio has a final implementation deadline for the banks as of January 2017, whereas the European Union has a final implementation deadline as of January 2019.<sup>15</sup> Thereby a faster U.S implementation of the NSFR is a likely scenario. For this reason, U.S. banks are likely to begin adjusting their balance sheets towards NSFR compliance at an earlier stage.

## 2.3 National Supervisory Adjustments

As mentioned above, the NSFR is designed upon internationally agreed definitions, which accommodate for the different liquidity and funding issues of banks in the member jurisdictions. The Basel Committee, however, allows for national discretion due to the large differences across countries. As a part of this discretion, supervisory assessment work will complement the calibration of the NSFR to specific member countries. Supervisors may require the adoption of stricter standards for individual banks in order to match their specific funding and liquidity risk profiles. This is done as an effort to ensure compliance with the *Sound Principles*. More specifically, the required and available stable funding described in the NSFR regulation are calibrated to the assumed level of liability stableness and asset liquidity in the given member states.<sup>16</sup>

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<sup>12</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), October 2014, Page 2.

<sup>13</sup> Danske Bank – CRD/CRR, April 2014.

<sup>14</sup> European Commission, *CRD IV/CRR – Frequently Asked Questions*, European Commission, March 2013.

<sup>15</sup> Debevoise & Plimpton, *Client Update: Basel Committee Adopts Net Stable Funding Ratio: How Much Liquidity Is Enough?*, Debevoise & Plimpton, December 2014, page 4-5.

<sup>16</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), October 2014, Page 2.

The ASF evaluation of a bank's liabilities is based on funding tenor and funding type/counterparty. When evaluating the funding tenor, longer-term liabilities with maturities of more than one year are assumed to be more stable than short-term liabilities with maturities of less than one year. The likelihood of interruptions in long-term liabilities is lower than for short-term liabilities. This makes liability tenor an important measure in liquidity risk profile assessments.<sup>17</sup> Regarding funding type, bank deposits from retail customers and small business owners are generally more stable as compared to wholesale funding. Retail deposit runs are unusual since retail customers rarely transfer their deposits between financial institutions. This is due to the switching and search costs of finding a new place to deposit the money, as well as the introduction of retail deposit insurance in many countries. Wholesale funding is considered less stable due to the lack of insurance. Furthermore, wholesale deposits are subject to the so-called roll-over risk. This refers to the ability of wholesalers to transfer deposits at deposit-contract termination.<sup>18</sup> Before the financial crisis of 2007 banks' balance sheet expansions were relying heavily on this short-term wholesale funding.

## 2.4 The NSFR Calculation Methodology

In order to calculate the Net Stable Funding Ratio, certain weighting factors are attached to the various balance sheet items. These factors differ depending on the degree of stability or liquidity of each single item on the liability or asset side of the balance sheet. As mentioned earlier, the NSFR framework uses two different sets of factors in order to separately calculate the numerator (Available Stable Funding) and the denominator (Required Stable Funding). The ASF and RSF factors range from 0 to 100 percent and they reflect the stability of funding for liability categories and the liquidity of asset categories. The higher the ASF factor, the higher the level of stability for the given liability item. As an example, regulatory capital will be assigned an ASF factor of 100 percent, whereas derivative liabilities will be assigned an ASF factor of 0 percent. This is due to the perceived instability of derivative instruments. Similarly, a liability item such as funding from a financial institution with residual maturity of less than six months will be assigned an ASF factor of 0 percent. The same logic applies to the assignment of RSF factors. Liquid assets receive low RSF factors while illiquid assets receive high RSF factors. As an example, central bank reserves are regarded to be very liquid and are therefore assigned an RSF factor of 0 percent. As another example, performing loans are also perceived to be rather liquid and will receive an RSF factor of

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<sup>17</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), October 2014, Page 3.

<sup>18</sup> Federal Reserve Bank of New York, *Economic Policy Review – Special Issue: The Stability of Funding Models*, Federal Reserve Bank of New York, February 2014, page 6.



85 percent. Some NSFR classifications of asset and liability categories have been adopted from the already existing definitions from the Basel Standards. The definition of "stable" deposits is for instance unchanged from the LCR framework. The same will apply for the categorization of "High Quality Liquid Assets" which is used to determine appropriate RSF factors for certain asset types under the NSFR framework.<sup>19</sup>

In order to construct the NSFR, the ASF numerator will be calculated by first assigning the carrying value of the bank's capital and liability items to their appropriate ASF categories. This assigning procedure is conducted in advance of any regulatory deductions, filters or other adjustments. As a second step the ASF factors are then multiplied onto the carrying values of each corresponding liability item. Finally, these weighted values are added together across ASF categories to get the value of a bank's available stable funding according to the NSFR framework.<sup>20</sup>

The construction process for the RSF measure follows a similar procedure. As a first step, all of the bank's assets are assigned to appropriate RSF factor categories based on their liquidity value and residual maturity. Secondly, the amounts assigned to each RSF category are then multiplied by their corresponding RSF factor. Finally, the weighted values are added together to give the combined sum across the different RSF categories.<sup>21</sup>

#### 2.4.1 The Available Stable Funding Factoring Methodology

As earlier mentioned, the amount of available stable funding is evaluated from the stability of a bank's funding sources. More specifically, the ASF weighting methodology incorporates the maturity and likelihood of withdrawal of funds from various types of funding providers in the factor assignment. When determining the exact maturity of a liability or equity instrument for the purpose of calculating the ASF, investors are always assumed to have a call option at the earliest possible date. This gives a conservative assessment of the true available funding resources. For long-term

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<sup>19</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), www.bis.org, October 2014, Page 8.

<sup>20</sup> Sherman & Sterling LLP, *Basel III Framework: The Net Stable Funding Ratio*, Client Publication, Financial Institutions Advisory & Financial Regulatory, December 2014, Page 5.

<sup>21</sup> Sherman & Sterling LLP, *Basel III Framework: The Net Stable Funding Ratio*, Client Publication, Financial Institutions Advisory & Financial Regulatory, December 2014, Page 6.

liabilities, only the portion of cash flows appearing at, or after, the one-year time-horizon should be treated as having this effective residual maturity for the purpose of NSFR calculation.<sup>22</sup>

The following overview and analysis of the ASF factoring methodology departs from the initial NSFR proposal from the Basel Committee as of December 2010. As mentioned earlier, changes have been made to the final and revised NSFR framework as of October 2014. These changes are rather limited and are mainly based on small changes in the weighting of certain balance sheet items. A full overview of the changes is provided at the end of this section in table 2.5.

#### 2.4.1.1 Liabilities Qualifying for a 100 Percent ASF Factor

The liabilities and capital instruments that receive a 100 percent ASF factor are comprised of three elements. Total regulatory capital, total capital not included in regulatory capital with an effective residual maturity above one year, and total secured and unsecured borrowings and liabilities with effective residual maturity of one year or more. Total regulatory capital is assigned before any capital deductions, as defined in paragraph 49 of the Basel III declaration<sup>23</sup>. The regulatory capital is segmented into tier 1 and tier 2 capital. Tier 1 capital covers common equity, share premium, retained earnings, and accumulated other comprehensive income, while tier 2 capital mainly covers instruments and share premiums not included in tier 1 capital.<sup>24</sup> This shows the relative importance of having sufficient tier 1 capital in order to ensure adequate available stable funding. In terms of total secured and unsecured borrowing, the cash flows that arises before the one-year horizon of long-term liabilities will not qualify for a 100 percent ASF factor.<sup>25</sup>

#### 2.4.1.2 Liabilities Qualifying for a 90 Percent ASF Factor

Liabilities receiving a 90 percent ASF factor are comprised of two main elements. Stable non-maturity deposits as defined in paragraphs 75 to 78 of the LCR framework, and term deposits with residual maturities of less than one year provided by retail and small business customers. Stable non-maturity deposits are deposits that are fully insured by an effective deposit insurance scheme or by state guarantee. In addition, the depositor must have multiple relationships with the bank. The

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<sup>22</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), www.bis.org, October 2014, Page 4.

<sup>23</sup> Basel Committee on Banking Supervision, Basel III: *A global regulatory framework for more resilient banks and banking systems*, Bank for International Settlement (BIS), www.bis.org, June 2011, page 12.

<sup>24</sup> Central Bank of Bahamas, *Extract from Basel III: A Global Regulatory Framework For More Resilient Banks and Banking Systems: Definition of Common Equity Tier I, Additional Tier I and Tier II Capital*, Central Bank of Bahamas.

<sup>25</sup> Basel Committee on Banking Supervision, Basel III: *A global regulatory framework for more resilient banks and banking systems*, Bank for International Settlement (BIS), www.bis.org, June 2011, page 12.

last requirement is based on an assumption that the likelihood of deposit withdrawal is smaller when the depositor has multiple engagements with the bank. Deposits in transactional accounts such as salary accounts are also considered stable non-maturity deposits in accordance with the above requirements. An effective deposit insurance scheme refers to a scheme that meets the following three requirements: (i) Guarantees prompt payouts, (ii) The coverage is clearly defined, and (iii) The public awareness is high. Furthermore, the deposit insurer needs to be operationally independent, transparent, and accountable.<sup>26</sup> As mentioned, wholesale funding is considered more risky than funding provided by retail and small business customers. It is therefore not included in the 90 percent ASF factor.

#### 2.4.1.3 Liabilities Qualifying for a 80 Percent ASF Factor

Liabilities receiving an 80 percent ASF factor comprise less-stable non maturity deposits and term deposits. The term "less-stable" defines deposits that are not fully insured by an effective deposit insurance scheme as described above.<sup>27</sup>

#### 2.4.1.4 Liabilities Qualifying for a 50 Percent ASF Factor

The 50 percent ASF factor comprises unsecured funding with residual maturity below one year which is provided by non-financial corporate customers, sovereigns, public sector entities (PSEs), and multilateral and national development. Furthermore, it includes operational deposits provided by non-financial corporates. Operational deposits qualifying for a 50 percent ASF factor should arise from customers which are reliant on the bank to perform cash management activities as a third party provider. If the bank is aware of that a customer has alternative arrangements that can provide such services it does not qualify. Additionally, the operational deposit handling must be provided under a legally binding agreement with the institutional customers. This agreement must be subject to either a termination period of minimum 30 days or significant switching costs in the case that termination can be called in less than 30 days. The above reflects the increased risk of funds withdrawal when an alternative cash management solution exists and/or the relationship between the parties is neither non-binding nor significant. If an excess balance exists beyond what is considered sufficient for operational purposes, it doesn't qualify for a 50 percent ASF factor. Only the portion of a deposit balance that can be proven to serve the operational needs of the customer

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<sup>26</sup> Basel Committee on Banking Supervision, Basel III: *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), January 2013, page 21.

<sup>27</sup> Banking Committee on Banking Supervision, Basel III Consultative Document: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), January 2014, Annex 1.

are considered stable. If banks are unable to classify a sufficient deposit for operational purposes, the entire deposit should be considered non-operational.<sup>28</sup>

#### 2.4.1.5 Liabilities Qualifying for a 0 Percent ASF Factor

The 0 percent ASF factor includes all liabilities and equity not considered in the other categories. This includes funding from central banks and financial institutions of less than one year. Similarly, other liabilities with maturity between six months and one year, as well as liabilities without a stated maturity such as short positions are included in this 0 percent ASF category.<sup>29</sup>

#### 2.4.1.6 Summary of the ASF Factoring Methodology

| ASF Factor | Liabilities included in ASF classification   |
|------------|--|
| 100%       | <ul style="list-style-type: none"> <li>• Total regulatory capital (excluding Tier 2 instruments with residual maturity of less than one year)</li> <li>• Other capital instruments and liabilities with effective residual maturity of one year or more</li> </ul>   |
| 90%        | <ul style="list-style-type: none"> <li>• Stable non-maturity (demand) deposits and term deposits with residual maturity of less than one year provided by retail and small business customers.</li> </ul>  |
| 80%        | <ul style="list-style-type: none"> <li>• Less stable non-maturity deposits and term deposits with residual maturity of less than one year provided by retail and small business customers</li> </ul>   |
| 50%        | <ul style="list-style-type: none"> <li>• Unsecured funding with residual maturity of less than one year provided by non-financial corporate customers.</li> <li>• Funding with residual maturity of less than one year from sovereigns, PSEs, and multilateral and national development banks.</li> </ul>  |
| 0%         | <ul style="list-style-type: none"> <li>• All other liabilities and equity not included in the above categories, including liabilities without a stated maturity (with a specific treatment for deferred tax liabilities and minority interests).</li> <li>• NSFR derivative liabilities net of NSFR derivative assets if NSFR derivative liabilities are greater than NSFR derivative assets.</li> <li>• “Trade date” payables arising from purchases of financial instruments, foreign currencies and commodities.</li> <li>• Other funding with residual maturity between six months and less than one year not included in the above categories, including funding provided by central banks and financial institutions.</li> </ul> |

Table 2.4.1.6: ASF allocation overview for NSFR calculation.<sup>30 31</sup>

<sup>28</sup> Basel Committee on Banking Supervision, Basel III: *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, Bank for International Settlements (BIS), www.bis.org, January 2013, page 24-27.

<sup>29</sup> Basel Committee on Banking Supervision, Basel III: *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, Bank for International Settlements (BIS), www.bis.org, January 2013, page 67.

<sup>30</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), www.bis.org, October 2014, Page 6.

<sup>31</sup> Banking Committee on Banking Supervision, Basel III Consultative Document: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), www.bis.org, January 2014, Annex 1.

## 2.4.2 The Required Stable Funding Factoring Methodology

The amount of required stable funding is evaluated from the stability and liquidity risk of assets and off-balance sheet exposures. Each asset type is assigned to one of eight different RSF factor categories. An RSF factor is intended to approximate the value of particular assets that will have to be funded within a one-year time horizon. This funding need can be due to roll-over or because the asset cannot be sold or used as collateral in a secured borrowing transaction in a one-year time horizon without incurring a large cost. According to the NSFR framework, such amounts need to be supported by available stable funding on the liability side of the balance sheet. In determining the residual maturity of an instrument, it should be assumed that investors will exercise any embedded option to extend the maturity of the asset. An example of this could be loans. These extensions will increase the required stable funding and thereby require banks to find available stable funding to satisfy the NSFR requirement.<sup>32</sup>

### 2.4.2.1 Encumbered Assets

Encumbered assets are limited by legal, regulatory or contractual restrictions in the ability of banks to assign, transfer, sell, or liquidate them. This can be exemplified by securitization of assets or assets used as collateral. These procedures limit the flexibility and liquidity of assets, why they are important in calculating the required stable funding. Balance sheet assets that are encumbered for one year or more, are assigned to the 100 percent RSF factor category. Alternatively, assets encumbered between six months and one year receives a 50 percent RSF factor. Furthermore, assets encumbered between six months and one year which would receive an RSF factor above 50 percent if they were unencumbered, will maintain the higher RSF factor. Assets encumbered for less than six months receive an RSF factor similar to unencumbered assets.<sup>33</sup>

### 2.4.2.2 Assets Qualifying for a 0 Percent RSF Factor

Only the most liquid types of assets will receive an RSF factor of 0 percent. This category consists of coins and banknotes that are immediately available to meet an obligation. All central bank reserves will be considered fully liquid, both required reserves as well as excess reserves. Furthermore, a 0 percent RSF factor will be assigned to all claims on central banks with residual

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<sup>32</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), October 2014, Page 7.

<sup>33</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), October 2014, Page 7.

maturities of less than six months. The same will apply for trade date receivables arising from sales of various financial instruments, foreign currencies and commodities.<sup>34</sup>

#### 2.4.2.3 Assets Qualifying for a 5 Percent RSF Factor

The category of assets that qualifies for a 5 percent RSF factor comprise marketable securities that represents claims on, or that are guaranteed by a specific range of counterparties. These counterparties are central banks, public sector entities, (PSEs), the Bank for International Settlements, the International Monetary Fund, the European Central Bank, sovereigns, the European Community or multilateral development banks. The assets will have to meet a range of criteria in order to be assigned the 5 percent RSF factor. First, eligible assets should be assigned a 0 percent risk-weight under the Basel II Standardized Approach for credit risk.<sup>35</sup> Second, they should be traded in large, deep and active repo or cash markets that are characterized by a low level of concentration. Third, the assets must have proven to be a reliable source of liquidity in the financial markets, even under very stressed market conditions. Lastly, the assets may not be an obligation of a financial institution or any of its affiliated entities.<sup>36</sup>

#### 2.4.2.4 Assets Qualifying for a 10 Percent RSF Factor

This RSF category includes unencumbered loans to financial institutions with a residual maturity of less than six month. These unencumbered loans must be secured against Level 1 assets as defined in paragraph 50 of the LCR framework.<sup>37</sup> The definition of Level 1 assets comprises coins, banknotes, and central bank reserves including required reserves. In addition, all of the marketable securities in the 5 percent RSF factor category that meets the requirements in paragraph 50 of the LCR framework are also a part of the Level 1 assets definition. Lastly, unencumbered loans where the bank has the ability to freely rehypothecate<sup>38</sup> the received collateral for the duration of the loan will also be assigned a 10 percent RSF factor.<sup>39</sup>

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<sup>34</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), October 2014, Page 8.

<sup>35</sup> The Basel II Standardized Approach refers to a set of credit risk measurement techniques proposed under Basel II capital adequacy rules for banking institutions. Under this approach banks are required to use ratings from External Credit Rating Agencies to quantify required capital for credit risk.

<sup>36</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), October 2014, Page 9.

<sup>37</sup> Basel Committee on Banking Supervision, Basel III: *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, Paragraph 50, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), January 2013, Page 18.

<sup>38</sup> Rehypothecation is a method to enable funding or to enhance its cost by re-using valuable assets that have been posted by clients to collateralize own borrowing.

<sup>39</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), October 2014, Page 9.

#### 2.4.2.5 Assets Qualifying for a 15 Percent RSF Factor

Assets qualifying for a 15 percent RSF factor in the NSFR framework are so-called Level 2A assets as defined in paragraph 52 the LCR framework. These Level 2A assets divide themselves into three main categories: Marketable securities, corporate debt securities and other unencumbered loans to financial institutions with a residual maturity of less than six months.<sup>40</sup> A thorough description of the requirements that these assets need to fulfil in order to be eligible for a 50 percent RSF factor is outlined in appendix V.

#### 2.4.2.6 Assets Qualifying for a 50 Percent RSF Factor

The asset category that qualifies for a 50 percent RSF factor comprises a large range of financial items. One of these items is the unencumbered Level 2B assets as described in paragraph 54 of the LCR framework. The Level 2B asset classification consists of residential mortgage backed securities (RMBS), corporate debt securities and common equity shares.<sup>41</sup> A thorough description of the requirements that the above items need to fulfil in order to be eligible for a 50 percent RSF factor is outlined in appendix VI.

#### 2.4.2.7 Assets Qualifying for a 65 Percent RSF Factor

The 65 percent RSF factor category comprises unencumbered residential mortgages with a residual maturity of at least one year. These unencumbered residential mortgages should qualify for a risk factor of maximum 35 percent according to the Basel II Standardized Approach for credit risk. The 65 percent RSF factor category also includes a range of other unencumbered loans. Among these are loans to financial institutions that have a residual maturity of at least one year, as well as loans that would qualify for a 35 percent or lower risk factor under the Basel II Standardized Approach for credit risk.<sup>42</sup>

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<sup>40</sup> Basel Committee on Banking Supervision, Basel III: *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), January 2013, Page 19.

<sup>41</sup> Basel Committee on Banking Supervision, Basel III: *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, Paragraph 54, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), January 2013, Page 20.

<sup>42</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), October 2014, Page 10.

#### 2.4.2.8 Assets Qualifying for an 85 Percent RSF Factor

Those assets that are eligible for an RSF factor of 85 percent include cash, securities and other types of assets that are used for posting as initial margin for derivative contracts.<sup>43</sup> Cash or other assets that are a part of a derivative contract and serves as contribution towards the default fund of a central counterparty will also be subject to an RSF factor of 85 percent. However, if the securities or assets posted for initial margin would otherwise receive a higher RSF factor according to other financial regulations, these assets should retain that higher RSF factor.<sup>44</sup> Unencumbered performing loans with residual maturities of at least one year that do not qualify for the 35 percent or lower risk weight under the Basel II Standardized Approach for credit risk are also included in the 85 RSF factor category.<sup>45</sup> From this classification, loans to financial institutions will have to be excluded, while loans to retail and small business customers will be included.<sup>46</sup>

#### 2.4.2.9 Assets Qualifying for a 100 Percent RSF Factor

The 100 percent RSF factor category comprises a large range of different types of assets. First, the category includes all assets that are encumbered for a time horizon of at least one year. Second, the amount of NSFR derivative assets net of derivative liabilities, as calculated according to paragraphs 19, 20, 34 and 35 of the Basel III NSFR framework.<sup>47</sup> This derivative asset type will only be included if the NSFR derivative assets are greater than the derivative liabilities.<sup>48</sup> The third type of asset that will be eligible for a 100 percent RSF factor will include non-performing loans, loans to financial institutions with a residual maturity of at least one year, non-exchange-traded equities, fixed assets, items deducted from regulatory capital, retained interest, insurance assets, subsidiary interests and defaulted securities. The fourth element of this RSF category will be 20 percent of a bank's derivative liabilities as calculated according to paragraph 19 of the NSFR framework.<sup>49</sup> This works as a negative replacement cost amount and has to be calculated before deducting the posting of variation margin for the contract. The 100 percent RSF classification will furthermore apply to

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<sup>43</sup> In the case that the initial margin is posted by the customer, and the bank does not guarantee performance of the third party in the agreement, then this posted amount of assets will be exempt from the requirement.

<sup>44</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), www.bis.org, October 2014, Page 10.

<sup>45</sup> A performing loan is characterized by not being more than 90 days past due in accordance with paragraph 75 on page 25 in the Basel II framework. Conversely, a non-performing loan will be defined as a loan that is more than 90 days past due.

<sup>46</sup> Banking Committee on Banking Supervision, Basel III Consultative Document: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), www.bis.org, January 2014, Annex 1.

<sup>47</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), www.bis.org, October 2014, Page 4.

<sup>48</sup> For calculation purposes, the RSF will be defined as:  $RSF = 100\% * \text{Max}((\text{NSFR derivative assets} - \text{NSFR derivative liabilities}), 0)$

<sup>49</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), www.bis.org, October 2014, Page 4.



unencumbered securities with a residual maturity of at least one year, and physical, traded commodities including gold.<sup>50</sup>

### 2.4.3 Off-Balance Sheet Exposures

When calculating the NSFR it is necessary to include off-balance sheet items with a certain amount of weight. Even though off-balance sheet exposures have no or limited immediate funding requirements, they can lead to severe long-term liquidity drains. To incorporate this, the NSFR assigns a moderate RSF factor to off-balance sheet activities in order to ensure sufficient funding within a one-year time horizon.

The NSFR divides off-balance sheet exposures into three categories. These are credit facilities, liquidity facilities and other types of contingent funding obligations. In the case of irrevocable and conditionally revocable credit and liquidity facilities to any type of client, these will be assigned a RSF factor of 5% of the currently undrawn portion.<sup>51</sup>

As a part of the NSFR framework, national supervisors are allowed to assign RSF factors to off-balance sheet items based on specific circumstances in each jurisdiction. The national discretion will apply to a large range of contingent funding obligations that includes various products and instruments. These products are unconditionally revocable credit and liquidity facilities, trade finance-related obligations including guarantees and letters of credit as well as guarantees and letters of credit unrelated to trade finance. This national discretion also includes non-contractual obligations, such as potential requests for debt repurchases of the bank's own debt. Lastly, it includes securities investment vehicles and other similar financing facilities.

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<sup>50</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), October 2014, Page 10.

<sup>51</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), October 2014, Page 12.

## 2.4.4 Summary of the RSF Factoring Methodology

| RSF Factor | Assets included in RSF classification   |
|------------|---|
| 0%         | <ul style="list-style-type: none"> <li>• Cash: Coins and Banknotes</li> <li>• All types of central bank reserves</li> <li>• All claims on central bank reserves with residual maturities of less than six months</li> <li>• Sales of financial instruments, foreign currencies and commodities (Trade-date receivables)</li> </ul>  |
| 5%         | <ul style="list-style-type: none"> <li>• Unencumbered Level 1 assets, excluding coins, banknotes and central bank reserves</li> </ul>   |
| 10%        | <ul style="list-style-type: none"> <li>• Unencumbered loans issued to financial institutions with a residual maturity of less than six months. These loans will have to be secured against Level 1 assets as defined in paragraph 50 in the LCR framework. In addition, the bank should have the ability to freely rehypothecate the received collateral for the life of the loan</li> </ul>  |
| 15%        | <ul style="list-style-type: none"> <li>• All other types of unencumbered loans to financial institutions with residual maturities less than six months, that are not included in the above categories</li> <li>• Unencumbered Level 2A assets</li> </ul>  |
| 50%        | <ul style="list-style-type: none"> <li>• Unencumbered Level 2B assets</li> <li>• Loans to financial institutions and central banks with residual maturities between six months and one year</li> <li>• Deposits held at other financial institutions for operational purposes</li> </ul>  |
| 65%        | <ul style="list-style-type: none"> <li>• Unencumbered residential mortgages with a residual maturity of at least one year with a risk of at maximum 35 percent according to the Basel II Standardized Approach</li> <li>• Other unencumbered loans not included in the above categories, excluding loans to financial institutions, with a residual maturity of at least one year and a risk weight of at maximum 35 percent under the Basel II Standardized Approach.</li> </ul>   |
| 85%        | <ul style="list-style-type: none"> <li>• Cash, securities or other types of assets posted as initial margin for derivative contracts and cash or other assets provided to contribute to the default fund of a central counterparty</li> <li>• Other unencumbered performing loans with risk weights greater than 35 percent under the Basel II Standardized Approach, and with residual maturities of at least one year, excluding loans to financial institutions</li> </ul>   |
| 100%       | <ul style="list-style-type: none"> <li>• All assets that are encumbered for a period of at least one year</li> <li>• NSFR derivative assets net of NSFR derivative liabilities, if the NSFR assets are greater than the NSFR liabilities, otherwise, the factor becomes 0%</li> <li>• 20 percent of derivative liabilities as calculated according to paragraph 19 in the LCR framework</li> <li>• All other assets not included in the above categories, including non-performing loans, loans to financial institutions with a residual maturity of more than one year, non-exchange-traded equities, fixed assets, items deducted from regulatory capital, retained interest, insurance assets subsidiary interests and defaulted securities</li> <li>• Unencumbered securities with residual maturity of one year or more that are not in default, and exchange-traded securities</li> <li>• Physical traded commodities, including gold</li> </ul> |

Table 2.4.4: RSF allocation overview for NSFR calculation.<sup>52</sup>

<sup>52</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), www.bis.org, October 2014, Page 11.

## 2.5 Factoring Methodology Changes from December 2010 to October 2014

| Available Stable Funding (ASF)  |  |
|---|--|
| Recognition of operational deposits   | <ul style="list-style-type: none"> <li>Operational deposits were not recognized in the 2010 NSFR, and would have received a 0% ASF factor (except for operational deposits from non-financial corporates); all operational deposits have now been included in the category receiving a 50% ASF factor</li> </ul>   |
| Clarification of secured funding treatment  | <ul style="list-style-type: none"> <li>A distinction is no longer made between secured and unsecured funding for funding maturing in less than one year from non-financial corporate customers; both are given a 50% ASF factor; in the 2010 NSFR, only unsecured funding from non-financial corporates maturing in less than one year received a 50% ASF factor; by implication, secured funding from the same counterparties received a 0% ASF factor.</li> </ul>    |
| Higher ASF factors for stable non-maturity deposits and term deposits                             | <ul style="list-style-type: none"> <li>“Stable” non-maturity deposits and term deposits now receive a 95% ASF factor compared with a 90% ASF factor in the 2010 NSFR.</li> <li>“Less-stable” non-maturity and term deposits now receive a 90% ASF factor compared with an 80% ASF factor in the 2010 NSFR.</li> </ul>  |
| Additional granularity for liabilities with residual maturities of less than one year             | <ul style="list-style-type: none"> <li>Some funding sources with a residual maturity of not less than six months and less than one year now receive a 50% ASF factor, compared with a 0% ASF in the 2010 NSFR.</li> </ul>  |
| Required Stable Funding (RSF)   |  |
| Greater consistency with the LCR HQLA definitions   | <ul style="list-style-type: none"> <li>Where applicable, references to Liquidity Coverage Ratio (LCR) definitions of Level 1, Level 2A, and Level 2B assets have been added to ensure greater consistency and alignment across the two standards; these assets have now been assigned RSF factors without regard to residual maturity</li> </ul>   |
| Lower RSF factors for unencumbered loans to retail and small business customers                   | <ul style="list-style-type: none"> <li>Unencumbered loans with a residual maturity of less than one year to retail and small business customers that do not qualify for a 35% or lower risk weight were lowered to 50% RSF factor from an 85% RSF factor in the 2010 NSFR.</li> </ul>  |
| Higher RSF factors for loans to non-bank financial institutions and non-HQLA securities.          | <ul style="list-style-type: none"> <li>Non-renewable loans to non-bank financial institutions and non-HQLA securities with a residual maturity of less than one year did not require any stable funding in the 2010 NSFR, but have now been placed in the category requiring a 50% RSF factor.</li> </ul>  |
| Additional granularity and lower RSF factors for certain other non-HQLA                           | <ul style="list-style-type: none"> <li>Certain assets with risk weights greater than 35% under the Basel II Standardized Approach, including unencumbered performing loans with residual maturity of one year or greater, unencumbered non-HQLA securities not in default, physical traded commodities and exchange-traded equities have been moved to a category requiring an 85% RSF factor from a category requiring a 100% RSF factor in the 2010 NSFR.</li> </ul> |
| Higher RSF for HQLAs encumbered for a period of six months or more and less than one year         | <ul style="list-style-type: none"> <li>HQLA encumbered for a period of six months or more and less than one year were previously treated as unencumbered in the 2010 NSFR but have now been assigned a 50% RSF factor.</li> </ul>  |
| Higher RSF factor for interbank lending for a period of six months or more and less than one year | <ul style="list-style-type: none"> <li>Interbank lending for a period of six months or more and less than one year is now assigned a 50% RSF factor (compared with 0% in the 2010 NSFR) and is treated symmetrically on the funding side with a 50% ASF factor for interbank borrowing for a period of six months or more and less than one year.</li> </ul>   |

Table 2.5: Changes in the NSFR from December 2010 to October 2014.<sup>53</sup>

<sup>53</sup> Banking Committee on Banking Supervision, Basel III Consultative Document: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), www.bis.org, January 2014, Annex 1.

### 3. Hypotheses on Accommodation for the Net Stable Funding Ratio

The following section will initially provide a set of arguments and findings for the fact that banks are already accommodating for the NSFR, and have been doing so since its announcement in 2010. This section also outlines the hypotheses that we want to test as a part of our analysis. As we explain the hypotheses, we will also provide rationales for why the given hypothesis seems reasonable to test.

#### 3.1. NSFR Motivated Balance Sheet Adjustments

Banks will not have to meet the NSFR requirement with full compliance until January 2018. In the light of this, one might ask if the banks have made NSFR motivated balance sheet adjustments up until now. Despite the fact that banks have been allowed a large amount of time in order to comply with the NSFR, several factors motivate an investigation of banks' possible, early adoption of the NSFR. These are discussed in the following section.

Throughout a series of meetings with different people from Danske Bank it was made clear that the liquidity requirements are something that Danske Bank had been looking into for quite some time. As a part of this, they had been discussing potential adjustment procedures on their balance sheet in order to be able to comply with the requirement.<sup>54</sup> Furthermore, two of the derivative traders in Danske Markets emphasized that especially the derivative desks of banks were thinking a lot about potential adjustments.<sup>55</sup> The reason for this is the severe penalization of derivatives on a bank's balance sheet according to the NSFR calculation methodology as will be outlined later. In general, the people we interviewed from Danske Bank suggested that many of the larger banks would probably initiate the adoption of the NSFR well ahead of time, especially if large balance sheet positions would have to be moved around. These considerations advocate for an investigation of possible NSFR motivated balance sheet adjustments across banks already as of the announcement in 2010.<sup>56</sup>

A second driver of early NSFR motivated balance sheet adjustments is the banks' desire to comply with regulatory measures at the earliest possible date. After the financial crisis, banks are more heavily observed than ever by different market participants and monitoring institutions. Government entities are investigating banks to limit the risk of systemic crises in the banking sector, while financial analysts and traders analyze the profitability and default risk. These

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<sup>54</sup> Kohrmann, Agnethe. Senior Analyst at Group Treasury at Danske Bank, Interview on the 9th of March 2015.

<sup>55</sup> Ejdrup, Mathias and Hansen, Jess, Derivative Traders at Danske Markets, Interview on the 11th of March 2015.

<sup>56</sup> Arnt, Henrik. Kohrmann, Agnethe. Chief Analyst at Danske Markets and Senior Analyst at Group Treasury at Danske Bank, Interview on the 9th of March 2015.

observers ensure an on-going assessment of banks, which motivates a desire to comply with regulatory measures well ahead of time.<sup>57</sup>

As of now, there have been few academic publications on banks' historical NSFR implementation. Scalia (2013)<sup>58</sup> hypothesizes a number of balance sheet adjustments, financial market adjustments, and central bank adjustments following the introduction of the NSFR. This study collects a sample of European banks in the period from 2010 to 2012. Scalia (2013) uses chi-squared tests for differences in frequency distributions between a test and a control group. These tests control for adjustments motivated by the Liquidity Coverage Ratio, Leverage Ratio and a range of macroeconomic variables. The conclusion is that many banks have already made significant balance sheet adjustments in order to comply with the NSFR. However, it should be mentioned that Scalia (2013) applies a substantial amount of assumptions in the calculations, which to some degree troubles the study.

To sum up, it seems to be the case that certain market participants, as well as an academic study, believe that banks are trying to adapt towards the NSFR requirement well ahead of time. As will be outlined later, we will follow these concerns and the conclusion of Scalia (2013) when deciding upon our sampling window and constructing our dataset.

### 3.2. Hypothesis Rationales

According to the NSFR calculation methodology, certain balance sheet items will be more effective to adjust than others in order to comply with the NSFR. First of all, some balance sheet items will have a larger impact on the NSFR depending on the assignment of ASF and RSF factors. Balance sheet assets that receive large RSF factors will be able to make a large impact on the denominator of the NSFR, while liabilities that receive high ASF factors will be able to make a large impact on the numerator of the NSFR. Secondly, certain balance sheet items will be easier or less costly for banks to adjust. And thirdly, specific business strategies of particular banks might limit the potential set of balance sheet items that a bank would actually like to adjust. Based on these considerations, we construct a set of hypotheses regarding which balance sheet items that might be the true drivers of a bank's yearly changes in the NSFR. More specifically, we will express each selected balance sheet item as a ratio of total assets or total liabilities depending on where the item appears on the balance

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<sup>57</sup> Arnt, Henrik, Chief Analyst at Danske Markets, Kohrmann, Agnethe. Senior Analyst at Group Treasury at Danske Bank, Ejdrup, Mathias, Derivative Trader at Danske Markets, Interviews on the 9th of March 2015.

<sup>58</sup> Scalia, Antonio. Longoni, Sergio. Rosolin, Tizina, *The Net Stable Funding Ratio and banks' participation in monetary policy operations: some evidence for the euro area*, 2013, Banca'D Italia – Questioni di Economia e Finanza, Nr. 195

sheet. The reason for this is to examine banks' relative focus on different balance sheet items. This will be explained in detail in section 6 on the choice of econometric model. The hypotheses will be tested in order to identify those of the selected balance sheet items that might be significant and used-in-practice drivers of the changes in the NSFR. As stated earlier, we cannot guarantee causality between the changes in a given balance sheet item and the associated changes in the NSFR. However, we can test whether the yearly changes in the NSFR are significantly associated with the yearly adjustments in the ratio of a particular balance sheet item. In addition to this, we can compare the empirical pattern from the regression results to the behaviour that would be expected to take place if the balance sheet adjustments were to be motivated by NSFR compliance. If there is a match, it is at least very possible that the ratio of the given balance sheet item could serve the purpose of NSFR compliance. The testing method and the comparison will be explained in detail in section 6 on the choice of econometric model.

As outlined in the previous sections on the construction and weighting methodology of the NSFR, the NSFR comprises a large range of different balance sheet items. As we do not intend to analyze and test the potential effect from each single of these items, we have picked a particular set of eight different balance sheet items. Based on these, we have constructed a total of eight hypotheses regarding NSFR motivated balance sheet adjustments. These hypotheses have been constructed based on our own suspicions as well as ideas from a variety of internationally recognized consultancies and academic publications. These represent well-known and recognized companies such as PwC, Oliver Wyman, Accenture, McKinsey & Company, SIA Partners, and Danske Bank A/S. We have chosen to align some of our hypotheses with suspicions from these market participants as they all have resources and knowledge from multiple years of banking experience. In this way, we will be able to test the most debated components of the NSFR and also provide a high level of relevance in our investigation.

### 3.2.1 Hypothesis 1

*Banks' adjustment of the ratio of total securities to total assets is a significant driver of the yearly changes in the NSFR.*

According to the NSFR calculation methodology, securities are assigned different RSF factors depending on their risk-weight category. Depending on risk-category, each security receives an RSF factor of 0%, 15%, 50% or 100%. In a study from 2013, Michael R. King posts the suspicion that banks might use reductions in their stock of total securities as a way to improve their NSFRs.<sup>59</sup> The reason is that a high volume of securities, or a high ratio of securities to total assets, will result in an increased RSF denominator in the NSFR calculation. Furthermore, securities receive rather high RSF factors as compared to many other asset types on the balance sheet. In this way, the ratio of total securities to total assets is likely to be a significant driver of the yearly changes in banks' NSFRs. If the adjustments of the ratio of total securities to total assets were to be motivated by NSFR compliance, we would expect to observe a significant and negative relation between the yearly changes in the NSFR and the yearly changes in the ratio. This would show that in periods where the NSFR increases, this could be partly due to a reduction in the ratio of total securities to total assets of a given bank. The interesting part will be to test whether the changes in banks' NSFRs are associated with significant adjustments of the ratio of total securities to total assets. This would indicate that the ratio of total securities to total assets could be a used-in-practice tool for NSFR compliance.

### 3.2.2 Hypothesis 2

*Banks' adjustment of their ratios of low-risk and high-risk securities to total assets is a significant driver of the yearly changes in the NSFR.*

Hypothesis 2 is an extension to hypothesis 1. It was initially formulated by Michael R. King in his NSFR study from 2013.<sup>60</sup> It has been motivated by the fact that different security types are assigned different RSF factors based on their risk-weight category. Securities that are assigned low risk-weights will receive lower RSF factors while high-risk securities will be assigned high RSF factors. In this way, the ratios of different securities across risk-weight categories to total assets are likely to drive changes in the NSFR. In an NSFR perspective, banks could use shifts from high-risk to low-

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<sup>59</sup> King, Michael R., *The Basel III Net Stable Funding Ratio and bank net interest margins*, July 2013, Journal of Banking & Finance, Vol. 37, Page 4148.

<sup>60</sup> King, Michael R., *The Basel III Net Stable Funding Ratio and bank net interest margins*, July 2013, Journal of Banking & Finance, Vol. 37, Page 4148.

risk securities as a mean to improve their NSFRs. More specifically, increasing the ratio of low-risk securities while decreasing the ratios of high-risk securities to total assets would improve the NSFR. If the hypothesis is to be true, we would expect that in periods where a bank increases its NSFR, this will on average be followed by a significant change in the security mix. Many different scenarios for the change in security mix could reveal NSFR relevant adjustment behaviour. We will expect to observe significant and negative relations for the ratios of high-risk security types and/or significant and positive relations between the changes in the NSFR and the changes in ratios of low-risk security types to total assets. The exact pattern and whether it is potentially motivated by NSFR compliance will be examined in detail in section 7 on hypothesis testing.

### 3.3.3 Hypothesis 3

*Banks' adjustment of the ratio of total deposits to total liabilities is a significant driver of the yearly changes in the NSFR.*

Hypothesis 3 builds on a suspicion formulated by SIA Partners in December 2013.<sup>61</sup> The NSFR calculation methodology treats deposits on the liability side favourably by assigning high ASF factors to this particular type of funding. This indicates that the ratio of total deposits to total liabilities is likely to be a significant driver of the yearly changes in the NSFR. By shifting from other less favourably ASF treated liability items to a higher ratio of deposits, banks will be able to improve the ASF numerator of the NSFR and thereby improve the overall measure. In a strict NSFR perspective we would expect to find a significant and positive relation between the ratio of total deposits to total liabilities and the yearly changes in the NSFR.

### 3.3.4 Hypothesis 4

*Banks' adjustment of their ratios of low-risk and high-risk deposit types to total liabilities is a significant driver of the yearly changes in the NSFR.*

As an extension to hypothesis 3, banks can further increase the ASF numerator of the NSFR by focusing on those deposit types that receive the most favourable ASF treatment. From the Call Reports, total deposits can be segmented into six different deposit types: Long-term time deposits, short-term large time deposits, short-term small time deposits, transaction deposits, foreign deposits and wholesale deposits. Among these deposit types, long-term time deposits and short-term small

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<sup>61</sup> Finance & Strategy – The Financial Services blog of SIA Partners, *The Net Stable Funding Ratio: Definition and impacts on the financial sector*, SIA partners, <http://en.finance.sia-partners.com>, December 2013



time deposits receive the highest ASF factors of 100% and 90% respectively. According to this, it is likely that a particular deposit type as a share of total liabilities will be a significant driver of the yearly changes in the NSFR. In a strict NSFR perspective, it would be expected that the ratio of deposit types receiving high ASF factors would show a significant and positive relation with the yearly changes in the NSFR. Similarly, some of the four remaining deposit types will be expected to show a significant, but negative relation towards the yearly changes in the NSFR. This is due to the less favourable ASF treatment of these deposit types. However, a large range of different adjustment patterns could be NSFR relevant. As an example of this, a downwards adjustment of all of the ratios of the six different deposit types could still be interpreted as being NSFR relevant if the deposit types with low ASF factors are decreased relatively more than those with high ASF factors. An exact investigation of the adjustment pattern will be conducted as a part of the hypothesis testing. If the NSFR changes of banks are associated with significant adjustments of the different deposit ratios, it could indicate that the banks are using the adjustments in these deposit ratios as a way to change their NSFRs.

### 3.3.5 Hypothesis 5

*Banks' adjustment of the ratio of total derivatives to total assets is a significant driver of the yearly changes in the NSFR.*

The significance of derivatives as a used-in-practice tool for NSFR compliance has been emphasized in a range of meetings with different employees from Danske Markets.<sup>62</sup> This concern has also been raised by PricewaterhouseCoopers after the announcement of the final NSFR regulation from the Basel Committee in October 2014.<sup>63</sup> Derivative activities is one of the business areas of a bank on which the NSFR will have the largest impact. The NSFR contains a strict requirement to fund derivative assets with long-term funding which will increase the costs of conducting derivative trading. As a result of the decline in profitability from derivative transactions, banks are likely to reduce their derivative exposure towards the financial markets by lowering their outstanding volumes.<sup>64</sup>

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<sup>62</sup> Arnt, Henrik, Chief Analyst at Danske Markets, Kohrmann, Agnethe. Senior Analyst at Group Treasury at Danske Bank, Ejdrup, Mathias, Derivative Trader at Danske Markets, Interviews on the 9th of March 2015.

<sup>63</sup> PwC, Basel III breakfast briefing series, Stretched to the limit: Dealing with the implications of the NSFR, December 2014.

<sup>64</sup> Kjær, Peter Venø, Derivative Sales at Danske Markets, Interview on the 5th of March 2015.

The severe penalization of derivative activities stems from the 100% RSF factor attached to the difference between net derivative assets and net derivative liabilities after deduction of netting agreements, as well as the additional 20% RSF factor assignment to derivative liabilities.<sup>65</sup>

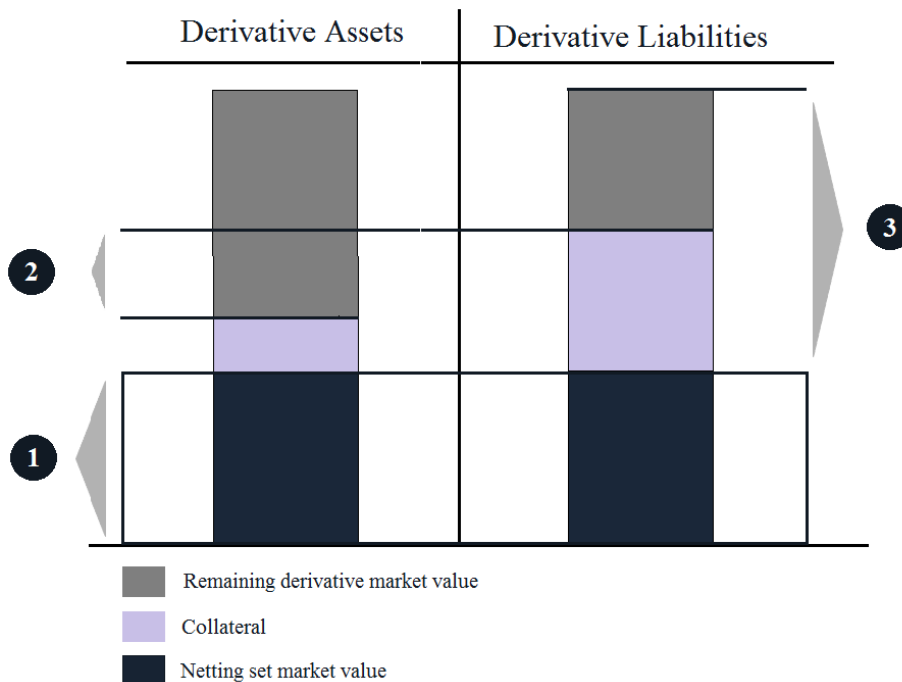


Figure 3.1: Illustration of the NSFR treatment of derivatives.

The net derivative asset position, as highlighted by (2) in the figure, will be assigned a 100% RSF factor. This will make it mandatory for banks to hold long-term funding corresponding to the calculated value of the net derivative assets. This net derivative asset amount is calculated as NSFR derivative assets minus NSFR derivative liabilities. It will only be assigned an RSF factor if the net amount is positive, meaning that the derivative asset value exceeds the derivative liability value. Those liability derivatives that are not netted with derivative asset positions will not receive any available funding recognition. These are assigned an ASF factor of 0%. A 20% RSF factor will be assigned to the derivative liabilities (3). This means that a large fraction of the collateral in the derivative contracts will have to be funded long-term. The initial margin that is posted by clients does not receive any available funding recognition either. However, the initial margin that is posted by the bank is required to be backed up by long-term funding equal to 85% of the value of the initial

<sup>65</sup> Banking Committee on Banking Supervision, Basel III: *The Net Stable Funding Ratio*, Bank for International Settlements (BIS), www.bis.org, October 2014, Paragraphs 34 and 35, Page 8.

margin.<sup>66</sup> According to the above, the ratio of total derivatives to total assets is likely to be a significant driver of the yearly changes in the NSFR.

In an NSFR perspective, it will be expected to observe a negative and significant relation between the ratio of total derivatives to total assets and the associated yearly changes in banks' NSFRs. The underlying mechanism for this expected empirical finding is the fact that an increase in the ratio of total derivatives to total assets will severely increase the RSF denominator of the NSFR. Simply put, a substitution towards the most RSF penalized asset category on the balance sheet will increase the need for stable funding and thereby decrease the overall NSFR measure.

### 3.3.6 Hypothesis 6

*Banks' adjustment of the ratio of high-quality liquid assets to total assets is a significant driver of the yearly changes in the NSFR.*

The suspicion underlying hypothesis 6 has been formulated by Accenture.<sup>67</sup> It builds on the fact that the Basel Committee has motivated the use of high-quality liquid assets (HQLA), to lower the weighted average risk of a bank's assets. HQLA covers cash as well as 0% and 20% risk-weighted securities in the Basel II Standardized Approach for credit risk.<sup>68</sup> These asset types are assigned low RSF factors, meaning that the HQLA components on a bank's balance sheet does not have to be covered by available stable funding. In a strict NSFR perspective, it will be expected to observe a significant positive relation between the yearly changes in the NSFR and the changes in a bank's ratio of total HQLA to total assets. This would indicate that banks are increasing their NSFRs by relying more heavily on the stock of HQLA as a proportion of their total assets. Of course, increases in the stock or the ratio of HQLA can serve many other purposes than NSFR compliance. However, if statistical significance is found, it could indicate that HQLA is a used-in-practice tool for NSFR compliance.

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<sup>66</sup> Oliver Wyman, *Impact of NSFR on Capital Markets: Considerations for implementation*, Oliver Wyman, January 2014, Page 13.

<sup>67</sup> Accenture, *Basel III and Its Consequences. Confronting a New Regulatory Environment*, Accenture, 2011, page 7.

<sup>68</sup> HQLA also includes reverse repos that are assigned risk-weights of 0% and 20% in the Basel II Standardized Approach for credit risk. However, as the amounts of reverse repos are not present as an isolated item in the Call Reports, we will not include the reverse repos in our HQLA calculations.

### 3.3.7 Hypothesis 7

*Banks' adjustment of the ratio of total lending to total assets is a significant driver of the yearly changes in the NSFR.*

Hypothesis 7 builds on a suspicion from SIA Partners.<sup>69</sup> The large RSF factors assigned to lending activities makes it an expensive business area in terms of NSFR compliance. A way for banks to improve the NSFR is then to decrease the RSF denominator by lowering the ratio of total lending to total assets. According to the NSFR calculation methodology, loans on a bank's asset side of the balance sheet are divided into four different risk-weighting categories of 0%, 20%, 50% and 100%. These four risk-weight categories are assigned RSF factors of 50%, 65%, 85% and 100% respectively, which penalizes the riskiness of the specific loan type. These RSF factors have been set at a relatively high level in comparison to other asset types, which provides the rationale for the suspicion of SIA Partners.

Lending activities can be adjusted for a large number of reasons, e.g. crisis management and balance sheet growth. However, in an NSFR perspective, we would expect to observe a significant and negative relation between the yearly changes in the NSFR and the yearly changes in the ratio of total lending to total assets. If this empirical pattern can be found, it will indicate that banks might be using the ratio of total lending to total assets as a way to adjust their NSFRs.

### 3.3.8 Hypothesis 8

*Banks' adjustment of their ratios of different risk-segmented loan types to total assets is a significant driver of the yearly changes in the NSFR.*

As outlined in the description of the NSFR calculation methodology, loans are penalized by the NSFR according to their risk categorization in the Basel II Standardized Approach for credit risk. Specifically, loans that are assigned to a higher risk-weight category will receive a higher RSF factor in the NSFR calculation methodology. This requires banks to have larger amounts of available stable funding on their liability side of the balance sheet in order to maintain a sound level of the NSFR. In this way, it seems that the ratios of different risk-segmented loan types to total assets could be a significant driver of the yearly changes in the NSFR. For banks working to improve their NSFR, it would be expected to see a positive and significant relation between the

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<sup>69</sup> Finance & Strategy – The Financial Services blog of SIA Partners, *The Net Stable Funding Ratio: Definition and impacts on the financial sector*, SIA partners, <http://en.finance.sia-partners.com>, December 2013.

yearly changes in the NSFR and the yearly changes in the ratio of low risk-weighted loan types to total assets. This means that when NSFR improvements are observed for any given period, it should be followed by a significant increase in the ratio of low-risk weighted loan types to total assets. Similarly, it will be expected that the ratios of high-risk weighted loan types are significant and negatively related drivers of the yearly changes in a bank's NSFR. Of course, other scenarios could indicate NSFR motivated adjustments as well. As an example, it could be that all loan types are adjusted downwards, where the ratios of high-risk loan types would be decreased relatively more than the low-risk loan types. As with any of our hypotheses, causality cannot be guaranteed since adjustments in the ratios of the different loan types can be an outcome of many other objectives of the banks. However, if the empirical findings match a pattern that could be motivated by NSFR compliance it will show that banks' adjustment of their ratios of different loan types to total assets could be a used-in-practice tool for NSFR compliance.

## 4. Method of Investigation

This subsection provides an overview of how previous academic publications have approached the calculation of the NSFR. This investigation will cover studies that have calculated the NSFR on an aggregated basis across countries, as well as studies that focus on the individual NSFRs of banks.

### 4.1 Assessment of Calculation Approaches and Data Sources for NSFR Analysis

In order to test our eight hypotheses we will have to be able to make a calculation of the NSFR for a given bank. The following section is meant as an overview of how previous academic publications have approached this issue. In this way, the purpose of this section is to assess the benefits and disadvantages of different calculation approaches and data sources that have been used for previous NSFR studies. This will allow us to select the most proper calculation method and data source for the purpose of our investigation.

Many researchers and practioners have attempted to calculate the NSFR. These publications have had different research goals as compared to our thesis. We do not analyze the content or findings from these articles in depth. Instead, we simply focus on the different approaches that have been taken towards calculating the NSFR. As a part of this focus, we will evaluate the quality of the calculation procedure as well as the granularity of the data that have been applied.

A comprehensive overview of the previous publications that we have investigated is shown in table 4.1 at the end of this section. All of these studies have been troubled by limited access to sufficiently segmented data. Specifically, the financial reporting of banks does not perfectly match with the NSFR components. This means that one cannot directly translate the items from publicly available balance sheets into the NSFR calculation scheme. An exact allocation of balance sheet data to the NSFR calculation scheme is therefore impossible. A number of different data sources provide balance sheet data that can be approximately applied to the NSFR categories. The problem is however, that a large number of assumptions will be needed in order to allocate the different balance sheet items into the NSFR calculation scheme. One of the earliest publications that provide NSFR calculations based on publicly available data is King (2010)<sup>70</sup>. In this study, Michael R. King evaluates the consequences of increased capital and liquidity requirements under Basel III onto bank lending spreads in 13 OECD countries from 1993 to 2007. King (2010) applies data from

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<sup>70</sup> King, Michael R., *Mapping capital and liquidity requirements to bank lending spreads*, Bank for International Settlement – BIS Working Papers, 324, November 2010

Bankscope<sup>71</sup> to calculate the NSFR. Bankscope provides a detailed and easily understandable segmentation of banks' balance sheets. However, the Bankscope data does not contain information on the segmentation of balance sheet items across maturity, risk-weighting, stability indication or item type (e.g. wholesale or retail). This is a significant issue, as the NSFR calculation scheme requires these to allocate various asset and liability components accurately. For this reason, King (2010) makes a number of assumptions in his NSFR calculation. Specifically, King (2010) categorizes 70% of all deposits in a bank to be stable and 50% to be wholesale-based<sup>72</sup>. On the other hand, he fully neglects the risk-weighting of various balance sheet assets.

In April 2011, the International Monetary Fund (IMF) published the “Global Financial Stability Report” (IMF (2011))<sup>73</sup>. The focus in this article is to address the key challenges faced by the global financial system in order to mitigate systemic risks in the banking sector. As a part of this study, NSFR calculations are made for 60 globally oriented banks across Europe, the U.S. and Asia in a period from 2005 to 2009. The IMF study uses data from Bankscope and acknowledges the issues arising in the NSFR calculations.

*“Overall, however, data issues remain a challenge in the analysis of the NSFR. The internal financial reporting systems of many banks are not consistent with the Basel categories. Further, the lack of harmonized public financial accounting data hinders a comparison of the rules across banks and jurisdictions”*<sup>74</sup>

Hence, IMF (2011) and King (2010) are both facing issues with the application of Bankscope data. In addition, IMF (2011) does not provide an explanation of the adjustments and assumptions made in their NSFR calculations. This limits the ability to replicate and verify the applied calculation approach.

A number of other academic publications have also applied Bankscope data in the calculation of the NSFR. However, none of these studies have been able to solve the issues encountered by IMF (2011) and King (2010). Ötoker-Robe (2010)<sup>75</sup> calculates the NSFR in order to analyze the impact of regulatory reforms on large financial institutions. For this, Ötoker-Robe (2010) uses data from

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<sup>71</sup> Bankscope, <https://bankscope.bvdinfo.com>, February 2015.

<sup>72</sup> King, Michael R., April 2016, Mail correspondence.

<sup>73</sup> International Monetary Fund (IMF), *Global Financial Stability Report*, IMF, 2011

<sup>74</sup> International Monetary Fund (IMF), *Global Financial Stability Report*, IMF, 2011, p. 78-79.

<sup>75</sup> Ötoker-Robe, Inci. Pazarbasioglu, Ceyla, *Impact of Regulatory Reforms on Large and Complex Financial Institutions*, International Monetary Fund – IMF Staffe Position Note, 2010.

European, Asian, and North American banks. Yan (2012)<sup>76</sup> calculates the NSFR for UK banks in a period from 1997 to 2010 as a part of a comprehensive cost-benefit analysis of Basel III. Cucinelli (2013)<sup>77</sup> calculates the NSFR as a part of an analysis of determinants of bank liquidity risk in the Eurozone. Chiaramonte (2013)<sup>78</sup> conduct a study on the NSFR following the financial crisis. This study covers European, North American, and Australian banks from January 2005 to December 2009. King (2013)<sup>79</sup> builds on the foundation of King (2010) by conducting a study of the effect of the NSFR on banks' net interest margins. Dietrich (2014)<sup>80</sup> calculates the NSFR for Western European banks in the period from 1996 to 2010. This study evaluates whether the NSFR can predict banks' financial performance. As a common denominator, these studies highlight the limitations and difficulties in applying Bankscope data for NSFR calculations. However, they all argue that Bankscope data can be used to derive fair approximations of the NSFR despite the lack of data granularity.

Another set of academic publications takes a different approach to the NSFR calculation. Angora (2011)<sup>81</sup>, Distinguin (2013)<sup>82</sup>, and Chalermæchatvichien (2013)<sup>83</sup> calculate NSFR by the application of Bloomberg data. Angora (2011) calculates a Net Stable Funding Difference (NSFD)<sup>84</sup> in order to analyze transformation risk and its determinants for a large sample of European and US commercial banks in a period from 2000 to 2008. Distinguin (2013) calculates the NSFR as a part of a study on regulatory capital and the liquidity of banks' assets. This study uses data for European and US Commercial banks from 2000 to 2006. Chalermæchatvichien (2013) calculates the NSFR in a study of the effect of bank ownership structure on capital adequacy, liquidity, and stability of banks for a sample comprising 11 East Asian countries in a period from 2005 to 2009. The balance sheet data granularity of Bloomberg is rather limited which makes the approximation of the NSFR somewhat imprecise. The key reason is the missing segmentation across risk-weightings for the banks' assets

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<sup>76</sup> Yan, Meilan. Hall, Maximilian, J.B. Turner, Paul, *A cost benefit analysis of Basel III: Some evidence from the UK*, International Review of Financial Analysis, 2012.

<sup>77</sup> Cucinelli, Doriana, *The Determinants of Bank Liquidity Risk within the Context of Euro Area*, Interdisciplinary Journal of Research in Business, 2, 51-64, 2013.

<sup>78</sup> Chiaramonte, Laura. Casu, Barbara. Bottliga, Roberto, *The Assesment of the Net Stable Funding Ratio and bank net interest margins*, Modern Bank Behaviour, 2013.

<sup>79</sup> King, Michael R., *The Basel III Net Stable Funding Ratio and bank net interest margins*, Journal of Banking & Finance, 37, 4144-4156, 2013.

<sup>80</sup> Dietrich, Andreas. Hess, Kurt. Wanzenried, Gabrielle, *The good and bad news about the new liquidity rules of Basel III in Western European countries*, Journal of Banking & Finance, 44, 13-25, 2014.

<sup>81</sup> Angora, Alain. Roulet, Caroline, *Transformation Risk and its Determinants: A New Approach based on the Basel III Liquidity Management Framework*, Preliminary draft - Universite de Limoges, 2011.

<sup>82</sup> Distinguin, Isabelle. Roulet, Caroline. Tarazi, Amine, *Bank regulatory capital and liquidity: Evidence from US and European publicly traded banks*, Journal of Banking & Finance, 37, 3295-3317, 2013.

<sup>83</sup> Chalermchatvichien, Pichaphop, *The Effect of Bank Ownership Concentration on Capital Adequacy, Liquidity, and Capital Stability*, J Financ Serv Res, 45, 219-240, 2013.

<sup>84</sup> The difference between RSF over total assets and ASF over total assets.



A third set of publications has been allowed access to non-publicly disclosed data in order to analyze the consequences of implementing the Basel III regulation. As an example, the European Banking Authority (2015)<sup>85</sup> has published a semi-annual document based on data from a sample of banks from the European Union. As participation in the survey is voluntary, the data is only reported on an aggregated basis to guarantee confidentiality. Due to the confidentiality and aggregation of the data, it is impossible to compare NSFR calculations from publicly available data sources to the true NSFR calculations made by the European Banking Authority. Similarly, the Bank for International Settlements (2015)<sup>86</sup> releases a semi-annual publication to monitor the impact of the NSFR based on data from a global pool of banks. As with the study from the European Banking Authority, it is not possible to compare results due to data confidentiality.

In the light of these outlined calculation issues, Hong (2014)<sup>87</sup> identifies a new approach to calculate the NSFR using public available Call Report data. These Call Reports are obtained from The Federal Financial Institutions Examination Council (FFIEC). The FFIEC is a formal U.S. government interagency body including five different banking regulators.<sup>88</sup> They provide financial information from regulatory reports of individual U.S. commercial banks. The FFIEC allow the public to extract Reports of Condition and Income, also known as Call Reports. Every national member<sup>89</sup>, state member<sup>90</sup>, and insured non-member state bank<sup>91</sup> is required to submit consolidated Call Reports on the last day of each quarter.<sup>92</sup> By the application of Call Report data<sup>93</sup> Hong (2014) is able to make a precise calculation of the NSFR. The calculations of Hong (2014) track a large set of banks throughout a time-window ranging from 2001 to 2011. In this study, the NSFR calculation incorporates both the maturity and the asset or liability type<sup>94</sup> as opposed to the Bankscope and Bloomberg based studies. However, the stability of certain balance sheet items and to some degree the split between deposit types will still have to be based on assumptions. In order to construct fair

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<sup>85</sup> European Banking Authority, *Results of the comprehensive quantitative impact study*, Comprehensive Quantitative Impact Study, 2015.

<sup>86</sup> Bank for International Settlement (BIS), 2015.

<sup>87</sup> Hong, Han. Huang, Jing-Zhi. Wu, Deming, *The information content of Basel III liquidity risk measures*, Journal of Financial Stability, 15, 91-111, 2014.

<sup>88</sup> The Federal Deposit Insurance Corporation; The Federal Reserve Board of Governors; The National Credit Union Administration; The Office of the Comptroller of the Currency; and The Consumer Financial Protection Bureau.

<sup>89</sup> National member bank: National bank that is a member of the federal reserve system (Central Bank system).

<sup>90</sup> State member bank: State bank that is incorporated under the laws of any of the United States of America that is a member of the Federal Reserve System (Central Bank system).

<sup>91</sup> Insured state non-member bank: State bank which is not a member of the federal reserve system, but where the deposits of which are insured with the provisions of the Federal Deposit Insurance Act.

<sup>92</sup> FFIEC Central Data Repository (CDR) Public Data Distribution (PDD) – Frequently asked questions (UBPR and Call Report), FFIEC, April 2015.

<sup>93</sup> Federal Deposit Insurance Corporation, April 2015.

<sup>94</sup> A balance sheet item type is based on whether the item is related to e.g. retail or wholesale.

assumptions, Hong (2014) uses sensitivity analysis to analyze the implication of different splits across deposit types and stability categories. Furthermore, Hong (2014) provides a detailed Call Report based NSFR allocation template. This makes it possible for the reader to replicate his results and to construct precise NSFR calculations.

The common factor for all of the above studies, as well as our thesis, is the need for a precise estimate of a bank's true NSFR. We have conducted a thorough review process of previous NSFR related academic publications in order to find the most precise calculation method and most granular data source available. From this investigation, we have found that it is possible to conduct a precise NSFR approximation by using Call Report data from the FFIEC combined with the granular NSFR allocation template from Hong (2014). In the following section on data and sample selection, we provide a detailed description of the use of Call Report data and the NSFR allocation template.

#### 4.1.1 Overview of Previous NSFR Publications

| Year | Author  | Publisher   | Title  | Source         |
|------|---|---|--|----------------|
| 2010 | Michael R King  | Bank for International Settlements - Working Papers | Mapping Capital and Liquidity Requirements to bank lending spreads   | Bankscope      |
| 2010 | Öker-Robe, Inci; Pazarbasioglu, Ceyla                 | IMF Staff Position Note                             | Impact of Regulatory Reforms on Large and Complex Financial Institutions   | Bankscope      |
| 2011 | International Monetary Fund                           | Global Financial Stability Report                   | Durable Financial Stability - Getting There from Here  | Bankscope      |
| 2011 | Angora, Alain; Roulet, Caroline,                      | Universite de Limoges, France                       | Transformation Risk and its Determinants: A New Approach based on the Basel III Liquidity Management Framework       | Bloomberg      |
| 2011 | Basel Committee on Banking Supervision                | Basel III Monitoring Reports                        | Results of the Basel Committee's latest Basel III monitoring exercise  | Volunteer Data |
| 2012 | Yan, Meilan; Hall, Maximilian J.B.; Turner, Paul      | International Review of Financial Analysis          | A cost-benefit analysis of Basel III: Some evidence from the UK  | Bankscope      |
| 2012 | European Banking Authority                            | Comprehensive Quantitative Impact Study             | Results of the comprehensive quantitative impact study   | Volunteer Data |
| 2013 | Distinguin, Isabelle; Roulet, Caroline; Tarazi, Amine | Journal of Banking & Finance                        | Bank regulatory capital and liquidity: Evidence from US and European publicly traded banks                           | Bloomberg      |
| 2013 | King, Michael R.                                      | Journal of Banking & Finance                        | The Basel III Net Stable Funding Ratio and bank net interest margins   | Bankscope      |
| 2013 | Cucinelli, Dorianna                                   | Journal of Research in Business                     | The Determinants of Bank Liquidity Risk within the Context of Euro Area  | Bankscope      |
| 2013 | Chiaromonte, Laura; Casu, Barbara; Bottiglia, Roberto | Modern Bank Behaviour                               | The Assessment of the Net Stable Funding Ratio (NSFR) Value. Evidence from the Financial Crisis                      | Bankscope      |
| 2013 | Chalermcharatvichien, Pichaphop                       | J Finance Serv Res                                  | The Effect of Bank Ownership Concentration on Capital Adequacy, Liquidity, and Capital Stability                     | Bloomberg      |
| 2013 | Scalia, Antonio; Longoni, Sergio; Rosolin, Tiziana    | Banca D'Italia - Questioni di Economia e Finanza    | The Net Stable Funding Ratio and banks' participation in monetary policy operations: some evidence for the euro area | Bankscope      |
| 2014 | Hong, Han; Huang, Jing-Zhi; Wu, Deming                | Journal of Financial Stability                      | The information content of Basel III liquidity risk measures   | Call Report    |
| 2014 | Michael Wosser  | Maynooth University, Ireland                        | The Determinants of Systemic Banking Crises  | The World Bank |
| 2014 | Gobat, Jeanne; Yanease, Mamoru; Maloney, Joseph       | IMF Working Paper                                   | The Net Stable Funding Ratio: Impact and Issues for Consideration  | Bankscope      |
| 2014 | Dietrich, Andreas; Hess, Kurt; Wanzentried, Gabrielle | Journal of Banking & Finance                        | The good and bad news about the new liquidity rules of Basel III in Western European countries                       | Bankscope      |

Table 4.1: Overview of previous NSFR publications.

## 5. Data and Sample Selection

This section provides an overview and explanation of the data applied in the calculation of the NSFR along with the data used for our panel data regressions. First of all, we outline the rationale for our choice of data source. Second, we describe how we have constructed our dataset for the panel data regressions. Lastly, we provide a section of descriptive statistics for the observed NSFR developments.

### 5.1 Choice of Data Source

In our choice of data source we follow Hong (2014) in the use of Call Reports from the Federal Financial Institutions Examination Council (FFIEC).<sup>95</sup> The FFIEC has been tracking the balance sheets of commercial banks in the U.S in a very detailed fashion since 1976. Furthermore, the FFIEC provides the most granular balance sheet overview available for our investigation purposes as outlined in section 4.1 on NSFR calculation approaches.

The Call Reports from the FFIEC include more than 3000 bank specific accounting entries segmented to a significantly higher degree than other data source alternatives such as Bankscope and Bloomberg. Application of less granular data will make it necessary to establish a substantial amount of approximations and assumptions. This will in the end attach a large amount of uncertainty to our final NSFR calculations. Our specific approach to find the most feasible data source for NSFR calculations have relied on a thorough comparison of estimation techniques as outlined in section 4.1. In addition to this, we have made sample calculations in order to get a precise understanding of the level of assumptions necessary in order to carry out the analysis. The data foundation and calculation methodology are very important as the NSFR is our primary variable for our hypothesis testing in the panel data regressions.

### 5.2 Mapping the Call Report Data to the NSFR Weighting Scheme

The mapping of Call Report accounting data to the NSFR calculation methodology aligns with the approach taken by Hong (2014). Using the Call Report allocation template posted in Table A.2 of Hong (2014), we are able to make individual NSFR calculations across banks. On the following pages, we have provided four tables that explain our NSFR calculation procedure in detail.

Table 5.2 (i) outlines how we have categorized the relevant Call Report accounting lines from a bank's liability side of the balance sheet into the ASF factor categories of the NSFR calculation

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<sup>95</sup> FFIEC, Federal Financial Institutions Examination Council, Call Reports extracted in April 2015.

methodology. As shown in the table, each specific Call Report accounting line is linked to the appropriate ASF factor as granularly as possible.

Table 5.2 (ii) explains how we have categorized the relevant Call Report accounting lines from a bank's asset side of the balance sheet into the RSF factor categories of the NSFR calculation methodology.

Table 5.2 (iii) provides an overview of our NSFR calculation based on Call Report accounting codes. Finally, table 5.2 (iv) explains how we have calculated the LCR, the Minimum Capital Requirements and the LR based on Call Report accounting codes. These variables are used as control variables in our regressions. This will be explained in detail in section 6 on the choice of econometric model.

Following the arguments posted by Hong (2014), Call Report data allows us to take maturity, risk-weighting and to some extent the type of assets and liabilities into account as opposed to Bankscope or Bloomberg data. The fact that we can segment balance sheet items across these characteristics is important in order to ensure a fair approximation of the NSFR. However, the Call Reports do not provide a fully segmented overview of all balance sheet items which will still make it necessary to impose some assumptions. These assumptions, however, will be much milder in nature as compared to application of Bankscope or Bloomberg data.

The first assumption imposed is the split between stable and less stable deposit accounts. Hong (2014) assumes an even distribution between stable and less stable deposits, while King (2010) and King (2013) assumes that 70% of deposits are stable<sup>96</sup>. We follow Hong (2014) due to the similarity in data sample demographics, as we also investigate commercial U.S. banks. King (2010) and King (2013) use a sample across 13 OECD countries. A second assumption regards the split of deposits between wholesale deposit accounts and retail deposit accounts. Both Hong (2014), King (2010), and King (2013) assumes an even distribution between wholesale and retail deposits, which is why we have chosen to align with this in our NSFR calculations. A third and final assumption regards the maturity of certain deposits. We follow Hong (2014) and assume that the share of deposits with a remaining maturity of less than one month makes out one third of the "time deposits"<sup>97</sup> with a remaining maturity of three months or less. Similarly, we assume that the share of "other borrowed

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<sup>96</sup> King, Michael R., April 2016, Mail correspondence.

<sup>97</sup>This is the accounting line name that is used in the Call Reports.

money"<sup>98</sup> with a remaining maturity of less than one month makes out one twelfth of time deposits with a remaining maturity of one year. Lastly, we assume that the share of deposits with a remaining maturity below one month in "foreign deposits"<sup>99</sup> is one twelfth. Specifically, these three variables are used to calculate the LCR. As will be outlined later, we will include this liquidity requirement as a control variable in our regressions due to the fact that some balance sheet adjustments could be a result of LCR compliance.

### 5.2.1 Overview of the ASF Component Calculation of the NSFR

| Basel III NSFR Calculation Methodology  | Call Report Accounting Line  |
|---|--|
| Available Stable Funding (ASF)  |  |
| 100%  |  |
| <ul style="list-style-type: none"> <li>Total regulatory capital (excluding Tier 2 instruments with residual maturity of less than one year)</li> <li>Other capital instruments and liabilities with effective residual maturity of one year or more</li> </ul>  | <ul style="list-style-type: none"> <li>Tier 1 Capital</li> <li>Tier 2 Capital</li> <li>Time deposits with a remaining maturity of one year or more</li> <li>Other borrowed money with a remaining maturity of one year or more</li> </ul>  |
| 90%   |  |
| <ul style="list-style-type: none"> <li>Stable non-maturity (demand) deposits and term deposits with residual maturity of less than one year provided by retail and small business customers.</li> </ul>   | <ul style="list-style-type: none"> <li>Stable retail transaction deposits</li> <li>Small time deposits with a remaining maturity of less than one year</li> <li>Stable retail saving deposits</li> </ul>   |
| 80%   |  |
| <ul style="list-style-type: none"> <li>Less stable non-maturity deposits and term deposits with residual maturity of less than one year provided by retail and small business customers.</li> </ul>   | <ul style="list-style-type: none"> <li>Less stable retail transaction deposits</li> <li>Less stable retail savings deposits</li> </ul>   |
| 50%   |  |
| <ul style="list-style-type: none"> <li>Funding with residual maturity of less than one year provided by non-financial corporate customers.</li> <li>Operational deposits</li> <li>Funding with residual maturity of less than one year from sovereigns, PSEs, and multilateral and national development banks</li> <li>Other funding with residual maturity between six months and less than one year not included in the above categories, including funding provided by central banks and financial institutions.</li> <li>All other liabilities and equity not included in the above categories, including liabilities without a stated maturity (with a specific treatment for deferred tax liabilities and minority interests).</li> <li>NSFR derivative liabilities net of NSFR derivative assets if NSFR derivative liabilities are greater than NSFR derivative assets.</li> <li>"Trade date" payables arising from purchases of financial instruments, foreign currencies and commodities</li> </ul> | <ul style="list-style-type: none"> <li>Wholesale transaction deposits</li> <li>Wholesale saving deposits</li> <li>Large time deposits with a remaining maturity of less than one year</li> <li>Transaction deposits of states and political subdivisions in the United States</li> <li>Transaction deposits of U.S. Government</li> <li>Transaction deposits of foreign governments and official institutions</li> <li>Other borrowed money with a remaining maturity of less than one year</li> <li>Foreign deposits</li> </ul> |

Table 5.2 (i): Matching of Call Report accounting lines to ASF factor categories.

<sup>98</sup> This is the accounting line name that is used in the Call Reports.

<sup>99</sup> This is the accounting line name that is used in the Call Reports.

## 5.2.2 Overview of the RSF Component Calculation of the NSFR

| Basel III NSFR Calculation Methodology   | Call Report Accounting Line  |
|--|--|
| Required Stable Funding (RSF)  |  |
| 0%   |  |
| <ul style="list-style-type: none"> <li>• Cash: Coins and Banknotes</li> <li>• All types of central bank reserves</li> <li>• All claims on central bank reserves with residual maturities of less than six months</li> <li>• Sales of financial instruments, foreign currencies and commodities (Trade-date receivables)</li> </ul>   |  |
| 5%   |  |
| <ul style="list-style-type: none"> <li>• Unencumbered Level 1 assets, excluding coins, banknotes and central bank reserves</li> </ul>  | <ul style="list-style-type: none"> <li>• Unused commitments</li> <li>• Letters of credit</li> <li>• Securities in 0% risk-weight category</li> </ul>   |
| 10%  |  |
| <ul style="list-style-type: none"> <li>• Unencumbered loans issued to financial institutions with a residual maturity of less than six months.</li> <li>• These loans will have to be secured against Level 1 assets as defined in paragraph 50 the LCR framework. In addition, the bank should have the ability to freely rehypothecate the received collateral for the life of the loan.</li> </ul>  |  |
| 15%  |  |
| <ul style="list-style-type: none"> <li>• All other types of unencumbered loans to financial institutions with residual maturities less than six months, that are not included in the above categories.</li> <li>• Unencumbered Level 2A assets</li> </ul>  | <ul style="list-style-type: none"> <li>• Securities in 20% risk-weight category</li> </ul>   |
| 50%  |  |
| <ul style="list-style-type: none"> <li>• Unencumbered Level 2B assets</li> <li>• Loans to financial institutions and central banks with residual maturities between six months and one year</li> <li>• Deposits held at other financial institutions for operational purposes</li> <li>• All other asset types not included in the above categories with residual maturities of less than one year, including loans to non-financial corporate clients, loans to retail and small business customers, and loans to sovereigns and PSEs.</li> </ul> | <ul style="list-style-type: none"> <li>• Securities in 50% risk-weight category</li> <li>• Loans in 0% risk-weight category</li> <li>• Trading securities in 0% risk-weight category</li> <li>• Other assets in 0% risk-weight category</li> </ul> |

Table 5.2 (ii) : Matching of Call Report accounting lines to RSF factor categories.

## 5.2.2 - Continued: Overview of the RSF Component Calculation of the NSFR

| Basel III NSFR Calculation Methodology   | Call Report Accounting Line  |
|--|--|
| Required Stable Funding (RSF)  |  |
| 65%  |  |
| <ul style="list-style-type: none"> <li>Unencumbered residential mortgages with a residual maturity of at least one year with a risk of at maximum 35 percent according to the Basel II Standardized Approach.</li> <li>Other unencumbered loans not included in the above categories, excluding loans to financial institutions, with a residual maturity of at least one year and a risk-weight of at maximum 35 percent under the Basel II Standardized Approach.</li> </ul>   | <ul style="list-style-type: none"> <li>Loans in 20% risk-weight category</li> <li>Trading securities in 20% risk-weight category</li> <li>Other assets in 20% risk-weight category</li> </ul>  |
| 85%  |  |
| <ul style="list-style-type: none"> <li>Cash, securities or other types of assets posted as initial margin for derivative contracts and cash or other assets provided to contribute to the default fund of a central counterparty.</li> <li>Other unencumbered performing loans with risk-weights greater than 35 percent under the Basel II Standardized Approach, and with residual maturities of at least one year, excluding loans to financial institutions.</li> <li>Unencumbered securities that are not in default and do not qualify as HQLA with a residual maturity of one year or more and exchange-traded securities.</li> <li>Physical traded commodities, including gold</li> </ul>  | <ul style="list-style-type: none"> <li>Loans in 50% risk-weight category</li> <li>Trading securities in 50% risk-weight category</li> <li>Other assets in 50% risk-weight category</li> </ul>  |
| 100%   |  |
| <ul style="list-style-type: none"> <li>All assets that are encumbered for a period of at least one year</li> <li>NSFR derivative assets net of NSFR derivative liabilities, if the NSFR assets are greater than the NSFR liabilities, otherwise, the factor becomes 0%.</li> <li>20 percent of derivative liabilities as calculated according to paragraph 19 in the LCR framework.</li> <li>All other assets not included in the above categories, including non-performing loans, loans to financial institutions with a residual maturity of more than one year, non-exchange-traded equities, fixed assets, items deducted from regulatory capital, retained interest, insurance assets subsidiary interests and defaulted securities</li> </ul> | <ul style="list-style-type: none"> <li>Securities in 100% risk-weight category and no risk-weight</li> <li>Loans in 100% risk-weight category and no risk-weight category</li> <li>Trading securities in 100% risk-weight category and no risk-weight category</li> <li>Other assets in 100% risk-weight category and no risk-weight category</li> </ul> |

Table 5.2 (ii) (Continued) : Matching of Call Report accounting lines to RSF factor categories.



### 5.2.3 Overview of the NSFR Calculation

| Weight |  | Available Stable Funding Components                             |                        | Call Report Section | Call Report RCON Codes |
|--------|--|---|------------------------|---------------------|------------------------|
| 100%   | Tier 1 Capital   | Schedule RC-R-Part I - Regulatory Capital Components and Ratios | RCON8274               | RCON85311           |                        |
|        | Tier 2 Capital   | Schedule RC-R-Part I - Regulatory Capital Components and Ratios | RCON85311              | RCON85311           |                        |
|        | Time deposits with a remaining maturity of one year or more                    | Schedule RC-E - Deposit Liabilities                             | RCONA581               | RCONA582            | RCONA586               |
|        | Other borrowed money with a remaining maturity of one year or more             | Schedule RC-E - Deposit Liabilities                             | RCONB56                | RCONF057            | RCONF058               |
| 90%    | Stable retail transaction deposits   | Schedule RC-E - Memoranda                                       |                        |                     |                        |
|        | Small time deposits with a remaining maturity of less than one year            | Schedule RC-E - Deposit Liabilities                             | RCONA241               |                     |                        |
|        | Stable retail savings deposits   |   |                        |                     |                        |
| 80%    | Less stable retail transaction deposits  | Schedule RC-E - Deposit Liabilities                             | RCONB549               |                     |                        |
|        | Less stable retail savings deposits  | Schedule RC-E - Deposit Liabilities                             | RCONB6810              | RCONF0352           |                        |
| 50%    | Wholesale transaction deposits   | Schedule RC-E - Deposit Liabilities                             | RCONB6549              |                     |                        |
|        | Wholesale savings deposits   | Schedule RC-E - Deposit Liabilities                             | RCONB6810              | RCONF0352           |                        |
|        | Large time deposits with a remaining maturity of less than one year            | Schedule RC-E - Deposit Liabilities                             | RCONK221               | RCONK222            |                        |
|        | Foreign deposits   | Schedule RC-E - Deposit Liabilities                             | RCONK221               | RCONK222            |                        |
|        | Other borrowed money with a remaining maturity of less than one year           | Schedule RC-M - Memoranda                                       | RCONK221               | RCONK221            |                        |
|        | Transaction deposits of U.S. Government  | Schedule RC-E - Deposit Liabilities                             | RCONK261               | RCONK261            |                        |
|        | Transaction deposits of states and political subdivisions in the United States | Schedule RC-E - Deposit Liabilities                             | RCONK202               | RCONK202            |                        |
|        | Transaction deposits of foreign governments and official institutions          | Schedule RC-E - Deposit Liabilities                             | RCONK203               | RCONK203            |                        |
|        |  | Schedule RC-E - Deposit Liabilities                             | RCONK216               |                     |                        |
|        |  |   |                        |                     |                        |
| Weight | Required Stable Funding Components   | Call Report Section   | Call Report RCON Codes |                     |                        |
| 5%     | Unused commitments   | Schedule RC-L - Derivatives and Off-Balance Sheet Items         | RCONK314               | RCONK315            |                        |
|        | Letter of credit   | Schedule RC-L - Derivatives and Off-Balance Sheet Items         | RCONK314               | RCONK315            |                        |
|        | Securities in 0% risk weight category  | Schedule RC-R-Part II - Risk-Weighted Assets                    | RCONB604               | RCONB609            |                        |
| 15%    | Securities in 20% risk weight category   | Schedule RC-R-Part II - Risk-Weighted Assets                    | RCONB605               | RCONB610            |                        |
| 50%    | Securities in 50% risk weight category   | Schedule RC-R-Part II - Risk-Weighted Assets                    | RCONB606               | RCONB611            |                        |
|        | Loans in 0% risk weight category   | Schedule RC-R-Part II - Risk-Weighted Assets                    | RCONB608               | RCONB623            |                        |
|        | Trading securities in 0% risk weight category                                  | Schedule RC-R-Part II - Risk-Weighted Assets                    | RCONB628               |                     |                        |
|        | Other assets in 0% risk weight category  | Schedule RC-R-Part II - Risk-Weighted Assets                    | RCONB641               |                     |                        |
| 65%    | Loans in 20% risk weight category  | Schedule RC-R-Part II - Risk-Weighted Assets                    | RCONB619               | RCONB624            |                        |
|        | Trading securities in 20% risk weight category                                 | Schedule RC-R-Part II - Risk-Weighted Assets                    | RCONB629               |                     |                        |
|        | Other assets in 20% risk weight category                                       | Schedule RC-R-Part II - Risk-Weighted Assets                    | RCONB642               |                     |                        |
| 85%    | Loans in 50% risk weight category  | Schedule RC-R-Part II - Risk-Weighted Assets                    | RCONB620               | RCONB625            |                        |
|        | Trading securities in 50% risk weight category                                 | Schedule RC-R-Part II - Risk-Weighted Assets                    | RCONB630               |                     |                        |
|        | Other assets in 50% risk weight category                                       | Schedule RC-R-Part II - Risk-Weighted Assets                    | RCONB643               |                     |                        |
| 100%   | Securities in 100% risk weight category and no risk weight                     | Schedule RC-R-Part II - Risk-Weighted Assets                    | RCONB607               | RCONB612            |                        |
|        | Loans in 100% risk weight category and no risk weight category                 | Schedule RC-R-Part II - Risk-Weighted Assets                    | RCONB621               | RCONB626            |                        |
|        | Trading securities in 100% risk weight category and no risk weight category    | Schedule RC-R-Part II - Risk-Weighted Assets                    | RCONB631               |                     |                        |
|        | Other assets in 100% risk weight category and no risk weight category          | Schedule RC-R-Part II - Risk-Weighted Assets                    | RCONK5339              |                     |                        |

Table 5.2 (iii): Calculation table for the NSFR using Call Reports.

## 5.2.3 Overview of the Calculation of Additional Liquidity Requirements

| Weight                                 | Liquidity Coverage Ratio Components   | Call Report Section   | Call Report RCON Codes |                   |  |
|--|---|---|------------------------|-------------------|--|
| Stock of high-quality liquidity assets |   |   |                        |                   |  |
| 100%                                   | A. Level 1 assets   |   |                        |                   |  |
|  | Cash  | Schedule RC - Balance Sheet                                   | RCON0081               | RCON0071          |  |
|  | Securities in 0% risk weight category                                       | Schedule RC-R Part II - Risk-Weighted Assets                  | RCONB604               | RCONB609          |  |
|  | Reverse repos in 0% risk weight category                                    | (Not reported)  |                        |                   |  |
| 85%                                    | B. Level 2 assets   |   |                        |                   |  |
|  | Securities in 20% risk weight category                                      | Schedule RC-R Part II - Risk-Weighted Assets                  | RCONB605               | RCONB610          |  |
|  | Reverse repos in 20% and 100% risk weight categories                        | (Not reported)  |                        |                   |  |
| Cash outflows                          |   |   |                        |                   |  |
| 5%                                     | Stable retail transaction deposits  |   |                        |                   |  |
| 5%                                     | Stable small time deposits with a remaining maturity of one month or less   |   |                        |                   |  |
| 5%                                     | Stable saving deposits  |   |                        |                   |  |
| 5%                                     | Stable foreign deposits with a remaining maturity of one month or less      |   |                        |                   |  |
| 10%                                    | Less stable retail transaction deposits                                     | Schedule RC-E - Deposit Liabilities                           | RCONB549               |                   |  |
| 10%                                    | Less stable small time deposits with a remaining maturity of one month or   | Schedule RC-E - Deposit Liabilities                           | RCONA579               |                   |  |
| 10%                                    | Less stable retail saving deposits  | Schedule RC-E - Deposit Liabilities                           | RCON6810               | RCON0352          |  |
| 25%                                    | Less stable foreign deposits with a remaining maturity of one month or less | Schedule RC-E - Deposit Liabilities                           | RCON2213               | RCON2236          |  |
| 5%                                     | Stable wholesale transaction deposits                                       |   |                        |                   |  |
| 25%                                    | Less stable wholesale transaction deposits                                  | Schedule RC-E - Deposit Liabilities                           | RCONB549               |                   |  |
| 75%                                    | Stable wholesale saving deposits  |   |                        |                   |  |
| 75%                                    | Stable large time deposits with a remaining maturity of one month or less   |   |                        |                   |  |
| 75%                                    | Less stable wholesale saving deposits                                       | Schedule RC-E - Deposit Liabilities                           | RCON6810               | RCON0352          |  |
| 75%                                    | Less stable large time deposits with a remaining maturity of one month or   | Schedule RC-E - Deposit Liabilities                           | RCONK221               | RCONK222          |  |
| 15%                                    | Secured lending backed by level 2 assets                                    | (Not reported)  |                        |                   |  |
| 100%                                   | All other secured funding transactions                                      | (Not reported)  |                        |                   |  |
| 100%                                   | Other liabilities   | Schedule RC - Balance Sheet + Schedule RC-M - Memoranda       | RCONF060               | RCON2930          |  |
| 100%                                   | Negative fair value of derivatives  | Schedule RC-D - Trading Assets and Liabilities                | RCON3547               |                   |  |
| 5%                                     | Unused commitments of home equity line of credit                            | Schedule RC-L - Derivatives and Off-Balance Sheet Items       | RCON3814               |                   |  |
| 5%                                     | Unused commitments of credit cards  | Schedule RC-L - Derivatives and Off-Balance Sheet Items       | RCON3815               |                   |  |
| 10%                                    | Unused commitments of commercial real estate                                | Schedule RC-L - Derivatives and Off-Balance Sheet Items       | RCONF164               | RCONF165 RCON6550 |  |
| 100%                                   | Unused commitments of securities underwriting                               | Schedule RC-L - Derivatives and Off-Balance Sheet Items       | RCON3817               |                   |  |
| 100%                                   | Other unused commitments  | Schedule RC-L - Derivatives and Off-Balance Sheet Items       | RCON3833               | RCONG591          |  |
| 5%                                     | Letters of credit   | Schedule RC-L - Derivatives and Off-Balance Sheet Items       | RCON3819               | RCON3821 RCON3411 |  |
| Cash inflows                           |   |   |                        |                   |  |
| 100%                                   | 50% of loans with a remaining maturity less than one month                  | Schedule RC-C Part I - Loans and Leases                       | RCONA247               |                   |  |
| 100%                                   | Positive fair values of derivatives   | Schedule RC-D - Trading Assets and Liabilities                | RCON3543               |                   |  |
| Weight                                 | Minimum Capital Requirement Components                                      | Call Report Section   | Call Report RCON Codes |                   |  |
| Eligible Capital                       |   |   |                        |                   |  |
| 100%                                   | Tier 1  | Schedule RC-R Part I.A - Regulatory Capital Components and Ra | RCON8274               |                   |  |
| 100%                                   | Tier 2  | Schedule RC-R Part I.A - Regulatory Capital Components and Ra | RCON5311               |                   |  |
| Exposure                               |   |   |                        |                   |  |
| 100%                                   | Total RW Assets   | Schedule RC-R Part II - Risk-Weighted Assets                  | RCONA223               |                   |  |
| Weight                                 | Leverage Ratio Components   | Call Report Section   | Call Report RCON Codes |                   |  |
| Eligible Capital                       |   |   |                        |                   |  |
| 100%                                   | Tier 1  | Schedule RC-R Part I.A - Regulatory Capital Components and Ra | RCON8274               |                   |  |
| Exposure                               |   |   |                        |                   |  |
| 100%                                   | Total Assets  | Schedule RC-K - Quarterly Averages                            | RCON3368               |                   |  |

Table 5.2 (iv): Calculation of LCR, Minimum Capital Requirements, and LR.

### 5.3 Constructing the Panel Data Set

In order to construct the data set, we have extracted yearly Call Reports for 6570 U.S. commercial banks from 2009 to 2014. The Call Reports are downloaded from the FFIEC's website<sup>100</sup>. The reason for choosing this time-window is the possibility to examine and test which of the included banks' balance sheet adjustments that have proven to be significant drivers of the NSFR. With respect to this, we want to limit our data set to the period in which banks have been aware of the NSFR. As will be explained in section 6, we want to measure our main variables as yearly changes. Since the Call Reports are sampled at the end of the fourth quarter each year, we have chosen to include 2009. We do this in order to be able to calculate the yearly change throughout 2010 where the NSFR was announced by the Basel Committee. In the construction of the dataset we have applied five different filters in order to extract and focus on the most relevant banks among the 6570 U.S. commercial banks available.

| Filter # | Filter Type                  | Filter Description  | Rationale  |
|----------|------------------------------|---|--|
| 1        | Data Cleaning                | Data availability for all six consecutive years: 2009 to 2014 | Criteria imposed in order to eliminate lack of yearly change calculations for regression                           |
| 2        | Data Cleaning                | Existence of bank throughout entire time-window               | Imposed to ensure proper application of panel data techniques and homogeneity of the sample across the time-window |
| 3        | Research Scope               | Total assets value of at least 2MM USD as of 2009             | Limiting the scope to banks within a relevant size range   |
| 4        | Data Cleaning/Research Scope | NSFR between 0,1 and 2  | Imposed in order to focus on a sensible range of NSFR values   |
| 5        | Data Cleaning/Research Scope | LCR between 0,1 and 4   | Imposed in order to focus on a sensible range of LCR values  |

Table 5.3: Data filtration steps for the final data sample construction.

The first criteria is implemented in order to ensure a clean panel data set from which regressions can be estimated without exclusion of observations due to missing data values for certain years for any specific bank.

The second criteria is included in order to construct a consistent sample across all 6 consecutive years. In combination with the first filter, this filter will ensure that we will get a balanced panel data set where the same set of banks will be present in each year.

The third filter is implemented in order to focus on the largest U.S. commercial banks. This will make our sample data as relevant as possible with respect to the investigation of potentially NSFR

<sup>100</sup> Federal Financial Institutions Examination Council, <https://cdr.ffiec.gov/public/>, April 2015.

relevant balance sheet adjustments. This filter was recommended by Henrik Arnt, Jess Hansen and Mathias Bredkjær from Danske Bank.<sup>101</sup> In alignment with their recommendations, we have chosen to focus on the 161 largest U.S banks that all meet the threshold of a total asset size of at least 2 billion USD. The people from Danske Bank argued that the most significant adjustments would be conducted by the largest banks, and that larger banks will need to launch their accommodation procedures well ahead of time in order to amend their massive balance sheets. By focusing on the largest banks there is a higher probability that the balance sheet adjustments that are associated with observed NSFR changes actually have been done with the purpose of NSFR compliance.

The fourth filter is included in order to exclude potential outlier values of the NSFR for certain banks, as well as to limit the data sample to the most relevant spectre for NSFR analysis.

The fifth filter is included in order to avoid LCR outliers. We are aware that our calculations of NSFR and LCR are approximated and this is why we want to filter out any misleading values from the final sample.

By focusing on banks that are in the relevant spectre with respect to changing their NSFR we can establish the best possible setting for investigating whether changes in our selected balance sheet items are NSFR relevant. After implementation of the above filtering criteria the final sample contains the 161 largest U.S. commercial banks. Each of these banks are measured along a large range of different balance sheet items and general bank characteristics.

First of all, we have included all of the balance sheet items that are necessary in order to calculate the NSFR and the LCR. Secondly, we have included a large range of control variables as well as time dummy variables. The control variables that we have included, and how they are calculated, will be explained in detail in section 6. Thirdly, all of our included variables and selected balance sheet items are represented as yearly changes as well as yearly changes in their ratio to total assets or total liabilities. Whether the ratio is calculated using total assets or total liabilities will depend on the balance sheet item's position on the balance sheet. Lastly, several variables and balance sheet items have been included in lagged and logarithmic editions for the purpose of potential relevance in the regression analysis.

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<sup>101</sup> The recommendation for the size filter for the data sample has been a part of a series of interviews conducted with various people from Danske Bank through February and March 2015.

The final panel data set includes 334<sup>102</sup> different variables, ranging from raw Call Report balance sheet items to calculated control variables for the purpose of our panel data regression. A consequence of implementing yearly changes in our variables is the exclusion of 2009 as a measurement year in the panel data. We have chosen to use the yearly changes in our variables as we want to investigate the association between the yearly changes in the NSFR and the yearly changes in our selected balance sheet items contained in the hypotheses. The final panel data set for regression purposes contains 805<sup>103</sup> bank specific observations.

## 5.4 Descriptive Statistics for the Net Stable Funding Ratio

In the table on the following page, we have outlined a summary of our main findings on the development of the NSFR. It can be observed that our sample of the 161 largest commercial banks in the U.S on average are centred fairly close around the NSFR target of 1. Furthermore, it can be seen that the banks on average do not follow a consistent trend in terms of NSFR adjustment over time. The average NSFR is adjusted upwards in 2010 and 2012, while slightly declining in 2011, 2013 and 2014. If we look at the standard error of the NSFR level throughout the time-window it can be seen that the banks on average are showing a declining distance to the NSFR target of 1. This shows that the largest U.S commercial banks are narrowing in towards the target. The skewness measure shows that as of 2009 the 161 largest commercial banks in the U.S were positively skewed. This means that the majority of the banks had NSFR levels below the target of 1, while a few banks had rather high NSFR levels. The positive skewness can also be seen from the fact that the median of the sample is lower than the mean. This positive skewness of the NSFR distribution declines throughout 2009-2014.

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<sup>102</sup> This number is an aggregation of the combined number of data columns in the entire data set. These 334 variables comprise raw Call Report accounting codes and a large range of calculated and transformed variables for regression purposes. An example of a transformed variable could be the yearly change in the ratio of a given asset item to total assets.

<sup>103</sup> The number 805 is obtained as we sample for the largest 161 banks for 5 consecutive years. Our time window comprises 6 years, but as we base our variables for regression on yearly changes, the year 2009 cannot be included in the sample. Therefore, 161 banks times 5 consecutive years equals 805 bank specific observations for our final data sample.

| Year | NSFR Level | Standard Deviation | Median | Skewness | Yearly Change in the NSFR | Standard Deviation | Total Assets | Yearly Change in Total Assets |
|------|------------|--------------------|--------|----------|---------------------------|--------------------|--------------|-------------------------------|
| 2009 | 1,0081     | 0,1806             | 0,9703 | 1,6221   |                           |                    | 4412689      |                               |
| 2010 | 1,0498     | 0,1781             | 1,0097 | 1,2677   | 0,0417                    | 0,0932             | 4626905      | 214216                        |
| 2011 | 1,0117     | 0,1739             | 0,9890 | 0,8594   | -0,0381                   | 0,0935             | 4922296      | 295391                        |
| 2012 | 1,0349     | 0,1854             | 1,0007 | 0,7711   | 0,0232                    | 0,0849             | 5507448      | 585152                        |
| 2013 | 1,0117     | 0,1777             | 0,9786 | 0,8123   | -0,0232                   | 0,0746             | 5886928      | 379480                        |
| 2014 | 0,9888     | 0,1659             | 0,9504 | 0,8942   | -0,0229                   | 0,0653             | 6551552      | 664624                        |

Table 5.4: Summary of descriptive statistics for the NSFR and yearly changes in the NSFR.

The overall finding from the descriptive statistics is that banks in general are close to their targets already as of 2009. It can also be observed that the distribution of the NSFR level is narrowing in while at the same time balancing out the positive skewness. This decreasing trend in skewness can be a result of two underlying mechanics: i) Underperforming banks are improving their NSFRs to a larger extent than overperforming banks. ii) Overperforming banks are cutting back on their NSFRs, or at least increasing them at a slower pace than the underperforming banks. Of course, the evident picture can also stem from a combination of these two effects, which is probably the most likely scenario. The underlying reasons, however, are not important for our investigation and regression analysis. The most important insight from the descriptive statistics is the fact that the NSFR distribution is consistently changing in shape over time even though the NSFR level is slightly fluctuating. The observation that banks are not consistently improving their NSFR levels on average can be due to a large range of different reasons. As a first reason, the sampled time-window comprises a period of financial turmoil as well as economic recovery. This indicates that banks have been occupied with other challenges than simply adjusting their balance sheet items towards NSFR compliance.

As can be observed in the average total assets development there has been a strong balance sheet growth throughout our sampled time-window. This indicates that banks have been focused on recovery and growing their business in the post-crisis years.

When looking at the development in the yearly changes of the NSFR, it can be observed that the absolute magnitude is declining consistently over time. This reveals that banks on average have undergone the largest NSFR changes early in the time-window, and well ahead of time, if these

adjustments were to be interpreted as being strictly NSFR relevant. It can also be seen that the standard deviation is declining over time, thereby indicating that the yearly NSFR changes of banks are becoming not only smaller, but also more homogenous across banks.

To sum up, the descriptive statistics reveal that consistent changes in the NSFR distribution have been taking place from 2009 to 2014. The next step will be to investigate which balance sheet items that are potentially causing these changes in the NSFRs of the banks.

## 6. Choice of Econometric Model

This section contains a detailed description of the construction of our panel data regression model as well as our choice of estimation technique. Next, we outline in detail all of the included explanatory variables that have been applied in the investigation. We explain why they have been included and how they have been calculated. Furthermore, we provide a description of the different units of measurement for our included variables. The purpose of this section is then to give a full rationale for our specific model setup and explain how our model can be used to test our hypotheses.

### 6.1 Model Requirements

Our goal is to determine how banks can adjust their balance sheets in order to comply with the NSFR. We want to do this by investigating which of our selected balance sheet items that can prove to be significant drivers of the yearly changes in the NSFR. From these results, we try to assess whether the balance sheet adjustments follow a pattern that matches NSFR relevant behavior. More precisely, we want to do two things: First of all, we want to test the statistical significance of each balance sheet driver. Secondly, we want to evaluate whether the adjustment patterns from the regression results align with NSFR relevant adjustments. For each of our outlined balance sheet items in the section on hypothesis rationales, we want to answer the following question.

*"When a change in a bank's NSFR is observed in a given period, is that on average followed by a systematic change in the ratio<sup>104</sup> of the given balance sheet item?"*

If this is the case, it will reveal that the particular balance sheet item has a significant impact onto the yearly changes of a bank's NSFR. Furthermore, it will show that the balance sheet item can serve as a potential tool for banks' NSFR compliance.

In order to establish a model that can properly answer this question, we need to apply yearly changes to each of our selected balance sheet items. This modification will apply to the response variable as well as the explanatory variables, except for certain control variables where the level of the variable might be of greater interest. When building the model, we have to be cautious about the functional relationship that exists between the NSFR and any of the balance sheet items that are a

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<sup>104</sup> When conducting our regression analysis we will use the ratio of a given balance sheet to total assets or total liabilities as the response variable. This is done in order to investigate how a bank's over business focus in terms of relative changes across its asset and liability items.



part of the NSFR calculation. The NSFR is calculated as a weighting of a large range of different asset and liability items from the balance sheet. This means that any balance sheet item that is covered by the NSFR calculation methodology will have a direct effect onto the level of the NSFR as well as the yearly changes in the NSFR. This functional effect could simply be calculated by examining the weight attached to the particular balance sheet item and its position in the numerator or denominator of the NSFR fraction. The functional relationship would appear if one were to regress changes in the NSFR onto the changes in, or the levels of, the balance sheet items. Since the balance sheet items that we have selected for our hypotheses are a subset of the balance sheet items covered by the NSFR calculation methodology, we need to arrange our model in order to handle this issue. If we were to regress changes in the NSFR onto the changes in the balance sheet items, we would simply estimate parameters that are already known and significant by construction. In this way, the functional relationship would lead to theoretical significance of all of the explanatory variables on the right hand side of the regression equation. In order to avoid this functional relationship, we place the yearly changes in a given bank's NSFR on the right-hand side of the equation. The idea is to regress the yearly changes in a balance sheet item onto the yearly changes in the NSFR, together with a range of relevant control variables. Using the yearly changes in the NSFR as an explanatory variable allows us to test the effects onto a particular balance sheet item when we observe a change in the NSFR. The NSFR can change for a large range of different reasons depending on which of the covered balance sheet items that have been adjusted. However, when regressing the yearly change of one particular balance sheet variable against the changes in the NSFR, it can be tested whether this balance sheet item has a significant association with the yearly changes in the NSFR.

As an additional modification to our selected variables, we have chosen to calculate any observation value of each balance sheet item as a ratio of total assets or total liabilities. The choice of denominator depends on whether the item appears on the asset side or the liability side of the balance sheet. In this way, we are able to examine the adjustments in the particular balance sheet item measured as a fraction of a bank's overall size. This means that the response variable in each of our specified regressions will be the yearly changes in the ratio of a given balance sheet item.

As examined in the scatter plot appendix<sup>105</sup>, it seems reasonable to incorporate linear effects from the yearly changes in the NSFR onto the yearly change in any particular balance sheet item. These plots show a clear linear association between the yearly changes in the NSFR and the yearly change in the ratio of each of our selected balance sheet items. Additionally, adjustments in the NSFR are very small within a one-year horizon and the same will be the case for the ratio of any of our selected balance sheet items. This means that our model primarily handles very small changes across the included variables, which makes it reasonable to apply linear effects. Furthermore, when we incorporate quadratic, cubic or log-transformed editions of our explanatory variables, these turn out to be insignificant. These findings advocate for the use of linear effects. All of the above considerations lead to the following panel data regression model.

$$\Delta \text{Ratio of Balance Sheet Item}_{i,t} = \beta_0 + \beta_1 \Delta \text{NSFR}_{i,t} + \beta_2 \text{Control}_{1,i,t} + \dots + \beta_{k+1} \text{Control}_{k,i,t} + u_{i,t}$$

A common assumption to apply is an assumption of parameter homogeneity in the model parameters. This means that the beta parameters as well as the intercept will be assigned the same value across all  $i$  banks and  $T$  time periods in the dataset.<sup>106</sup> As we want to investigate average effects across the banks in our sample, it seems reasonable to pool the beta parameters for all of the banks. We want to find and test the average effects onto different balance sheet item adjustments as a result of yearly changes in the NSFR.

In addition to the parameter homogeneity assumption, we also believe that certain unobserved effects will be present in our model. As will be outlined in the control variable section we have strived to net out the effects from other potential drivers of the yearly changes in the ratio of a given balance sheet item. Among these control variables, we have included other relevant liquidity requirements that have been in place throughout our sampling window from 2009 to 2014. Despite these efforts, we continue to believe that there exist bank specific factors that we cannot measure and incorporate as control variables in our model. Examples of such variables could be investment policies, preferences of the CEO, ease of regulation adoption and so forth. The possibility that such variables might exist could potentially lead to an omitted variable bias due to their impact on the yearly changes in the NSFR. If these variables and their impact are ignored, it will possibly lead to

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<sup>105</sup> Scatter plots of the yearly changes in the ratios of the balance sheet items versus the yearly changes in the NSFR can be found in Appendix 1 of the thesis.

<sup>106</sup> Wooldridge, M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 281. Our sample contains the largest 160 commercial banks in the U.S., sampled for 6 consecutive time periods in 2009 to 2014.

inconsistency in our parameter estimates.<sup>107</sup> An important criteria when conducting regression analysis is to ensure that the chosen estimator is consistent. Consistency means that an estimator has the property that, as the number of data points is increased, the sequence of parameter estimates will converge in probability towards the true population parameter. This feature is indeed relevant for the analysis, since we want to draw conclusions for any large commercial bank and not only those contained in our sample. If there is a strong lack of consistency, there will also be a low probability that our parameter estimates are equal to the true value of the population parameters.<sup>108</sup>

If any unobserved effects are present, we will have to decompose the error term into an idiosyncratic part and an unobserved effect that can be either time-varying or time-invariant.<sup>109</sup>

$$\Delta \text{Ratio of Balance Sheet Item}_{i,t} = \beta_0 + \beta_1 \Delta \text{NSFR}_{i,t} + \beta_2 \text{Control}_{1,i,t} + \dots + \beta_{k+1} \text{Control}_{k,i,t} + c_{i,t} + u_{i,t}$$

The idiosyncratic part,  $u_{i,t}$ , is assumed to be well behaved and independent of the regressors. On the other hand, a too strong correlation between the unobserved effects term,  $c_{i,t}$ , and the other regressors will result in an omitted variable bias. This will lead to inconsistency of the parameter estimates. In order to handle this issue, we have to consider how the unobserved effect behaves in relation to the other explanatory variables, and whether the error term contains autocorrelation. The purpose of this investigation is to determine whether a transformation of the variables in the regression is necessary. If the unobserved effect is correlated with the explanatory variables, we will have to apply e.g. a bank-specific demeaning procedure in order to eliminate the unobserved effect from our model. Or in the case that the error term displays autocorrelation, we will have to apply a first-differencing procedure to all variables in the model in order to eliminate the autocorrelation. These transformation procedures are used as an initial elimination tool, which is applied before estimating the parameters by regular OLS. This means that regardless of transformation choice, the model parameters will be estimated via a regular OLS procedure after the unobserved effect has been eliminated. However, a transformation of the variables will not be necessary if the unobserved effect is uncorrelated with the explanatory variables and the error term does not show autocorrelation. In this case, one can apply pooled OLS across the time periods in the data. The overall estimation procedure will then be twofold: As a first step, we will have to assess which

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<sup>107</sup> Wooldridge, M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 281.

<sup>108</sup> Wooldridge, M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 281-282.

<sup>109</sup> Croissant, Yves. Millo, Giovanni, *Panel Data Econometrics in R: The plm Package*, 2008, Journal of Statistical Software, vol. 27, Page 2.

estimator that fits best to the characteristics of our model. Secondly, we will have to apply regular OLS in order to estimate the parameters of the actual regression model. In terms of estimator choice, we consider the following four estimation techniques.

| Estimator          | Assumptions   | Validation/Rejection  |
|--------------------|---|---|
| Pooled OLS         | <ul style="list-style-type: none"> <li>Unobserved effect is uncorrelated with explanatory variables</li> </ul>  | <ul style="list-style-type: none"> <li>Assumption is invalid</li> <li>Risk of biased and inconsistent estimates<sup>110</sup></li> </ul>  |
| Random Effects     | <ul style="list-style-type: none"> <li>Unobserved effect is uncorrelated with explanatory variables</li> <li>Time-variant values<sup>111</sup></li> <li>Time-invariant effects<sup>112</sup></li> </ul>                   | <ul style="list-style-type: none"> <li>Assumptions are invalid</li> <li>Risk of biased and inconsistent estimates<sup>113</sup></li> <li>Consistency of the RE Estimator is rejected by a Hausman test<sup>114 115</sup></li> </ul> |
| Fixed Effects      | <ul style="list-style-type: none"> <li>Unobserved effect is correlated with explanatory variables</li> <li>Time-invariant values</li> <li>Time-invariant effects</li> <li>No serial correlation in error terms</li> </ul> | <ul style="list-style-type: none"> <li>Assumptions are full-filled</li> <li>Produces unbiased estimates if assumptions are correct<sup>116</sup></li> <li>Consistent estimator according to Hausman tests</li> </ul>                |
| First Differencing | <ul style="list-style-type: none"> <li>Error term correlated with regressors</li> <li>Serial correlation in errors terms</li> </ul>   | <ul style="list-style-type: none"> <li>Autocorrelation assumption is not full-filled<sup>117</sup></li> </ul>   |

Table 6.1: Comparison of transformation techniques for panel data regression.

In order to decide which of the four estimators that suits our regression model best, we have to evaluate the model along two dimensions. The first thing to consider is whether there exists correlation between the error term and the explanatory variables. The second step is to investigate whether there exists autocorrelation in the error term. Regarding the correlation issue, we have to discuss and test whether the unobserved effect part of the error term might be correlated with any of

<sup>110</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 301.

<sup>111</sup> The assumption of time-invariant values requires that the unobserved fixed effect is constant in terms of value across all time periods in the panel data.

<sup>112</sup> The assumption of time-invariant effects requires that the unobserved effect has the same impact towards the outcome across all time periods in the panel data.

<sup>113</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 281-282.

<sup>114</sup> Hausman test for comparison of random effect and fixed effect estimation has been conducted for our specified models and the consistency of the random effects estimator has been rejected in all cases.

<sup>115</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 328-329.

<sup>116</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 304.

<sup>117</sup> Autocorrelation tests are conducted by the application of Breusch-Godfrey tests and an example of this test is shown in the appendix IV.

the other explanatory variables in our regression. If it is the case, it will make our model subject to an omitted variable bias.

As will be outlined in section 6.3, other liquidity requirements such as the Leverage Ratio, The Tier 1 and 2 Capital Ratios and the Liquidity Coverage Ratio have been included in order to partly mitigate this. It is however still likely that certain bank specific factors that we have not included will have an effect onto the response variable of the model, as well as on the explanatory variables. As mentioned earlier, such effects could be e.g. investment policies, preferences of the CEO, ease of regulation adoption and so forth. If this assumption is valid one can rule out the application of pooled OLS and random effects estimation. This can be done since these estimators rely on the assumption of no correlation between the explanatory variables and the error term.<sup>118</sup>

We will assume that there does exist variables that we have not included which will be correlated with some of the explanatory variables in our model. This assumption relies on suspicions, as well as a formal test which will be shown later. Furthermore, we assume that these unobserved effects will be time-invariant in their values throughout our sampling window. We impose this assumption as it seems reasonable that the variables we cannot measure will be non-quantitative factors that are very likely to remain unchanged throughout our sampling window. We believe that we have captured the most crucial quantitative and measurable drivers of our selected balance sheet items and that any potential omitted covariates will be constant and qualitative of nature. As the unobserved effect is assumed to be time-invariant, the time subscript will disappear on the  $c_i$  term in our specified model.

$$\Delta \text{Ratio of Balance Sheet Item}_{i,t} = \beta_0 + \beta_1 \Delta \text{NSFR}_{i,t} + \beta_2 \text{Control}_{1,i,t} + \dots + \beta_{k+1} \text{Control}_{k,i,t} + c_i + u_{i,t}$$

In addition to the time-invariance assumption, we will also assume that the potential effect from the unobserved effects onto the response variable of our model is constant throughout time.

In order to formally test whether there does exist correlation between the unobserved effect and the explanatory variables in our model, we have conducted a series of Hausman tests. This tests works as a decision tool between the fixed effect and the random effect estimator.<sup>119</sup> The test is constructed in order to investigate which of these estimators that are consistent. This investigation is

<sup>118</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 281.

<sup>119</sup> Appendix II: "Hausman Test for Estimator Choice" provides an exemplification of the Hausman Test for estimator comparison between Fixed Effects and Random Effects.

carried out by testing the null hypothesis that both estimators as a starting point are consistent, but that the random effect is the efficient estimator due to its lower variance as compared to the fixed effects estimator.<sup>120</sup> Briefly explained, the Hausman test is based on the difference between the FE and RE estimates provided by each estimator. In the case where the error term is correlated with the explanatory variables the FE estimator will be consistent, whereas the RE estimator will be inconsistent. Based on this, a statistically significant difference in the estimates can be interpreted as evidence against the primary assumption underlying the application of the RE estimator, which is the non-existence of correlation between the explanatory variables and the error term. In this way, the Hausman test implicitly works as a formal test for endogeneity in our specified model.<sup>121</sup>

$H_0$ : No significant difference in estimates: Both estimators are consistent, but RE is efficient

$H_1$ : Significant difference in estimates, RE is inconsistent

The test is calculated as a Chi-squared statistic and is evaluated under the corresponding distribution.<sup>122</sup>

$$\text{Hausman Statistic} = (\hat{\beta}_{RE} - \hat{\beta}_{FE})^T * (\text{Var}(\hat{\beta}_{FE}) - \text{Var}(\hat{\beta}_{FE}))^{-1} * (\hat{\beta}_{RE} - \hat{\beta}_{FE})$$

Across our estimated models for each selected balance sheet item we obtain p-values well below the 5% significance threshold. This indicates that the RE estimator is inefficient and that does exist correlation between the error term and the explanatory variables. According to these results, the FE estimator has proved to be superior to the RE estimator.

The next step in order to select the best estimator is an assessment of the potential autocorrelation in the error term. If autocorrelation is present, we will have to apply a first-differencing procedure to all the variables in our model in order to eliminate this autocorrelation.<sup>123</sup> In order to test whether autocorrelation exists, we conduct a Breusch-Godfrey test. The Breusch-Godfrey test examines autocorrelation in the error term at a specified lag. More specifically, it tests the following hypothesis.

$H_0$ : No autocorrelation at lag h

$H_1$ : Autocorrelation at lag h

<sup>120</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 328.

<sup>121</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 328.

<sup>122</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 331.

<sup>123</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 281.

If autocorrelation is present, it will normally be the case that it appears at lag 1 or lag 2, which is tested below<sup>124</sup>. In our case, each model estimated by a fixed effects estimation procedure shows a p-value well above 5% for the Breusch-Godfrey tests. This indicates that we cannot reject the null hypothesis that there does not exist any autocorrelation at lag 1 or lag 2. Furthermore, we have examined the autocorrelation function for our produced error terms for lag 1 to 25. For each model estimated on a fixed effects basis, there is no signs of significant autocorrelation at a 5% significance level.<sup>125</sup>

To sum up, the above examination and test section advocates for the use of fixed effects estimation. This conclusion is based on three things: First of all, the Hausman tests indicated the existence of correlation between the error term and the explanatory variables in our specified models. This makes the random effect estimator inferior to the fixed effect estimator due to lack of consistency. Second, the Breusch-Godfrey tests for our models estimated by fixed effects rejected the existence of autocorrelation in the error term at lag 1 and 2. In addition to this, the autocorrelation functions of our models did not display signs of autocorrelation at any lag. This ruled out the application of the first-differencing estimator. Third, we have argued that there does exist certain bank-specific factors that we cannot measure, and that are correlated with the other explanatory variables in our model.

## 6.2 Fixed Effect Estimation

In general, panel data is useful when there is a suspicion that our response variables might depend on explanatory variables which are not observable or omitted, and when these are correlated with the other included explanatory variables. If these omitted variables can be expected to be constant over time, panel data estimators can allow for consistent and unbiased estimation of the effects onto the response variable. In the fixed effects model, the unobserved bank-specific effect is allowed to be correlated with the other explanatory variables. The purpose of the fixed effect estimator is then to eliminate this time-invariant bank-specific effect from the specified model. This elimination procedure is necessary before applying ordinary least squares estimation of the parameter estimates.<sup>126</sup> The elimination of the unobserved bank-specific effects in the error term is conducted by implementing a bank-specific demeaning procedure to all of the variables in our specified

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<sup>124</sup> It is very rare to discover autocorrelation at larger lags. However, plots of the autocorrelation function has been examined as well, in order to check for autocorrelation patterns at much larger lags.

<sup>125</sup> See Appendix IV: "*Test for Autocorrelation in Error Terms*" gives an exemplification of the Breusch-Godfrey test for autocorrelation at lag 1 and lag 2.

<sup>126</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 286.

model. The first step is to calculate the bank-specific averages across the five<sup>127</sup> periods for each relevant variable. This procedure is exemplified for the response variable.

$$\bar{y}_i = \frac{1}{T} \sum_{t=1}^T y_{it}$$

For each bank, this average is then subtracted from each observation value in order to demean the variable. In this way, we can obtain a new demeaned specified model where the time-invariant unobserved bank-specific effect,  $c_i$ , is eliminated.<sup>128</sup> Furthermore, the new demeaned model will not include a constant term,  $\beta_0$ , since this is also time-invariant and will be eliminated via the demeaning procedure as well.

In the academic literature, one denotes a demeaned panel data model by imposing double-dotted accents on top of the variables. Thereby the new demeaned model will take the following form.<sup>129</sup>

$$\ddot{y}_{it} = \beta \ddot{x}_{it}^T + \ddot{u}_{it}$$

For our specific case, the model will look as the following.

$$\Delta \text{Ratio of Balance Sheet Item}_{i,t} = \beta_1 \Delta \text{NSFR}_{i,t} + \beta_2 \text{Control}_{1,i,t} + \dots + \beta_{k+1} \text{Control}_{k,i,t} + \ddot{u}_{i,t}$$

After this demeaning procedure, the model has been netted for any unobserved bank-specific effects and can be estimated using regular OLS. Thereby, the fixed effect estimator will have the same structure as the OLS estimator, however, applied on a demeaned data matrix,  $\ddot{X}$ , and response variable  $\ddot{y}$ .<sup>130</sup>

$$\hat{\beta}_{FE} = (\ddot{X}^T \ddot{X})^{-1} \ddot{X}^T \ddot{y}$$

When applying the fixed effect estimator, three different assumptions are expected to be valid.<sup>131</sup>

$$\text{FE1: } E(u_{it}|X_i, e_i) = 0 \text{ for } t = 1, 2, \dots, T$$

Assumption FE1 requires strict exogeneity. This means that the error term of our estimated model must have a conditional mean of 0 and furthermore, that the error term will be uncorrelated with any of the other explanatory variables after implementation of the fixed effect estimator.<sup>132</sup>

<sup>127</sup> Since we apply yearly changes, (deltas) to our variables, 2009 cannot be included as an observation year for regression purposes. This leaves us with five observation periods for each of our 161 banks.

<sup>128</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 328-329.

<sup>129</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 328-329.

<sup>130</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 328-329.

<sup>131</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 300.



The second assumption is a rank condition. This condition needs to be fulfilled in order to ensure that the fixed effect estimator is well behaved. The rank condition is imposed to the matrix of demeaned explanatory variables.<sup>133</sup>

$$\text{FE2: Rank} \left( \sum_{t=1}^T E(\ddot{x}_{it}^T \ddot{x}_{it}) \right) = \text{Rank} \left( E(\ddot{X}_i^T \ddot{X}_i) \right) = K$$

This assumption ensures that no time-invariant explanatory variables are included in the data matrix for estimation. In the expression,  $K$  denotes the number of explanatory variables included in the model. Together, assumption FE1 and FE2 are sufficient to ensure that the fixed effect estimator is unbiased for a finite sample.<sup>134</sup>

The final assumption for the fixed effects estimator states that the variance of the error term must be constant.

$$\text{FE3: } E(u_{it}u'_{it}|x_i, c_i) = \sigma_u^2 I_T$$

This assumption implies that the idiosyncratic error term,  $u_{it}$ , have constant variance across our sampled time window and that no autocorrelation is present.<sup>135</sup> According to the test results in section 6.1, the above assumption can be verified.

### 6.3 Control Variables

As a first step towards finding a relevant range of control variables for our regressions, we have investigated the existing NSFR literature. Several articles on the topic of NSFR implementation have been using regression analysis and have different control variables in order to ensure causal interpretation of their relevant parameter estimates. However, only one<sup>136</sup> of these previous publications has directly studied the changes in the NSFR since its announcement in 2010. We have selectively included control variables that we believe have explanatory power towards our constructed ratios of selected balance sheet items.

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<sup>132</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 301.

<sup>133</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 304.

<sup>134</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 304.

<sup>135</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, 2nd Edition, 2010, Page 304.

<sup>136</sup> Scalia, Antonio. Longoni, Sergio. Rosolin, Tizinia, *The Net Stable Funding Ratio and banks' participation in monetary policy operations: some evidence for the euro area*, 2013, Banca'D Italia – Questioni di Economia e Finanza, Nr. 195

Previous studies of the NSFR have found that including the size of a given bank and the real GDP growth rate helps to explain changes in the NSFR. Angora (2011), Hong (2014), and Cucinelli (2013) all use bank size as a control variable in their regressions in order to limit the effect of differences across bank size. These studies control for bank size by implementing the logarithm of total assets. Bank size is an important control variable as heterogeneity is likely to exist between small and large banks on both the asset side and the liability side of the balance sheet. Larger banks will likely be able to obtain cheaper funding due to their size, and similarly be able to handle larger magnitudes of lending as compared to smaller banks. The inclusion of bank size as an explanatory variable might be able to control for such effects.

In order to assess how we can best control for a bank's size, we have tried to include total assets in a number of different ways. It has been included in its raw edition, in a logarithmic edition and in a quadratic edition. After estimation, each model was compared on its significance for the bank size control variable as well as the standard errors of the parameter estimates. From this trial and error process it turned out that the raw total assets measure was better than the transformed editions. For this reason, we have included the raw total assets variable from the Call Reports as our measurement of bank size.

As mentioned, Angora (2011), Cucinelli (2013) and Dietrich (2014) all include real GDP growth as a control variable in their regressions. They do this in order to control for the effects that could be stemming from macroeconomic fluctuations. The macroeconomic environment is likely to affect the investment decisions and activities of banks. An example of this could be the fact that demand for certain financial products may differ across economic booms and downturns. In a similar way to the process with the bank size variable, we have tried to include the real GDP growth in its raw edition, as well the yearly changes in real GDP growth. It turns out that the real GDP growth variable is the best choice in terms of significance and magnitude of standard errors across our models. The real GDP observations are extracted from Bloomberg and we have used 2009 as a baseline indexation year.

In addition to the bank size and the real GDP growth a number of other explanatory variables have been included in previous NSFR studies. Cucinelli (2013) and Angora (2011) controls for inflation and the level of the interest rate. We proxy the inflation rate with the growth in the U.S CPI, while the level of the interest rate is proxied by a 10 year U.S. government bond. Both of these variables

are extracted from Bloomberg. All relevant control variables, macroeconomic as well as bank specific, are included as yearly changes in the given control variable, as well as raw, year-specific observation values.

In addition to the above control variables that have been applied in previous NSFR studies, a number of additional explanatory variables are important for the purpose of our analysis. We have included the effects of other Basel III liquidity requirements. This seems reasonable since these liquidity requirements have been in place throughout our entire sampling window. Furthermore, these liquidity requirements include many of the same balance sheet items as the NSFR. This makes it necessary to control for changes in these requirements in order to net out their effect onto our selected balance sheet items. More specifically, certain balance sheet items will affect both the NSFR, the Liquidity Coverage Ratio, (LCR), and the Leverage Ratio, (LR). This makes it necessary to control for the fact that some balance sheet adjustments might not be conducted with the purpose of NSFR compliance, but with the purpose of compliance with other liquidity measures. In addition to the LCR and the LR, also the Tier 1 and Tier 2 capital ratios will be relevant control variables. These ratios also include some of the balance sheet items that are present in the NSFR calculation and they are indeed something that banks are accommodating for throughout our time window. In the following we provide a description of each of our control variables as well as a rationale for their inclusion.

### 6.3.1 Lagged NSFR Deficit

A given bank's choice to change its NSFR by adjusting one or more particular balance sheet items, will likely be a function of how far the bank is from the NSFR target of 1. As we sample our observation values for the banks at the end of the fourth quarter each year, it seems reasonable that a given year's change in the NSFR will be determined by the NSFR gap from the previous year, as measured of December 31. Therefore, we include a control variable calculated at time  $t$ , as 1 minus the NSFR level from the previous period. Thereby, the control variable will be positive whenever a given bank has a gap towards the target, and it will have a negative value if the target is outperformed.

$$\text{Lagged NSFR Deficit}_{i,t} = 1 - \text{NSFR}_{i,t-1}$$

When we construct the variable in this way, an increase in the lagged NSFR deficit variable will be expected to have a positive impact onto the balance sheet items that are suspected to drive the

NSFR upwards, and a similarly negative impact for balance sheet items that are suspected to drive the NSFR downwards. This means that the larger the NSFR deficit, the more likely it is that a bank will adjust the given balance sheet item.

### 6.3.2 Delta LCR

The Liquidity Coverage Ratio has been introduced in order to ensure that a bank has a sufficient stock of HQLA in order to meet its liquidity needs for 30 calendar days of financial stress. The stock of HQLA must consist of cash or assets that can be converted easily into cash. Specifically HQLA comprises cash and securities that are assigned risk-weights of 0% or 20% under the Basel II Standardized Approach for Credit Risk. Furthermore, the stock of HQLA should be subject to a minimal loss, if any, when converted into cash.<sup>137</sup> The stock of HQLA enters as the numerator in the LCR calculation, and the denominator consists of a measure called the total net cash outflows. The total net cash outflow is calculated as the total expected cash outflows minus the total expected cash inflows in the specified 30-day period.<sup>138</sup> For the exact calculation of the denominator, each single outflow and inflow receives a certain weight according to the LCR calculation methodology. The requirement for the banks is to maintain an LCR level of at least 100% at any point in time. This means that the total stock of HQLA will need to be able to overcompensate for the net cash outflows for a 30 calendar day period at any point in time. The LCR is set to be fully effective from the 1st of January 2019. However, the Basel Committee requires that banks meet a continuous threshold towards full compliance, meaning that bank's need to meet a 70% LCR already as of the 1st of January 2016. This requirement will increase by 10 percentage points each year until the banks are expected to fully comply with the 100% requirement in 2019. A detailed overview of how we calculate the LCR is provided in table 5.2 (iv).

The Liquidity Coverage Ratio, LCR, was introduced in December 2010 and was published in its final edition in January 2013. This means that the LCR has existed alongside with the NSFR throughout our entire sampling window. This makes it necessary to accommodate for the fact that banks might adjust some of our selected balance sheet items in order to adjust their LCR instead of their NSFR. In addition, some of our balance sheet items will affect the LCR and the NSFR in the same direction. This makes it possible that the observed changes in the balance sheet items are only

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<sup>137</sup> Basel Committee on Banking Supervision, Basel III: *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), January 2013, Page 10.

<sup>138</sup> Basel Committee on Banking Supervision, Basel III: *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), January 2013, Page 26.

partially relevant for our NSFR analysis. For these reasons, it will be necessary to net out the effects from potential LCR accommodation.

$$\Delta LCR_{i,t} = LCR_{i,t} - LCR_{i,t-1}$$

### 6.3.3 Lagged LCR Deficit

As with the NSFR, a bank's decision of whether to adjust its LCR will likely depend on how far this particular bank is from the LCR target of 100%. The inclusion of this control variable follows a similar rationale as the inclusion of the lagged NSFR deficit. Since we measure at the end of the fourth quarter each year, the LCR gap from the previous period will indicate the LCR deficit that a bank is facing in the current period. The lagged LCR deficit at time  $t$  is calculated as 1 minus the LCR level from the previous period.

$$\text{Lagged LCR Deficit}_{i,t} = 1 - LCR_{i,t-1}$$

### 6.3.4 Delta Leverage Ratio

The Leverage Ratio, LR, is introduced as a simple and non-risk based leverage ratio measure. The LR is intended to restrict the build-up of leverage in the banking sector in order to avoid destabilizing deleveraging processes that can damage the financial system. The numerator of the LR consists of a capital measure based on the Tier 1 capital from the risk-based capital framework of the Basel III regulation. Thereby, the numerator will be comprised of the total Tier 1 capital that a bank possesses. The denominator of the LR will consist of the total exposure of the bank. The total exposure is the sum of on-balance sheet exposures, derivative exposures, securities financing transactions exposures and off-balance sheet exposures.<sup>139</sup>

The Leverage Ratio was introduced in December 2010 and was published in its final edition in January 2014. This indicates that banks might have been adjusting balance sheet items in order to comply with the LR throughout our sampling window. Furthermore, a large set of the components of the NSFR will also be present in the calculation of the LR, thereby making it a relevant control variable. These similarities underline the uncertainty regarding whether the adjustments in our analyzed balance sheet items are solely NSFR relevant.

$$\Delta LR_{i,t} = LR_{i,t} - LR_{i,t-1}$$

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<sup>139</sup> Banking Committee on Banking Supervision, *Basel III: Revised Basel III leverage ratio framework and disclosure requirements*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), June 2013, Pages 1-2.

### 6.3.5 Lagged LR Deficit

According to the same rationale as the above lagged deficits, it is very likely that potential LR compliance will depend on the lagged LR deficit. The lagged LR deficit at time  $t$  is calculated as the Leverage Ratio target of 0,03<sup>140</sup> minus the LR level from the previous period.

$$\text{Lagged LR Deficit}_{i,t} = 0,03 - \text{LR}_{i,t-1}$$

### 6.3.6 Minimum Capital Requirement

The minimum capital requirements of the Basel III framework have also existed alongside the NSFR throughout our sampling window. The minimum capital requirements are a set of different criteria for different types of capital. The first part of the requirement is a capital threshold of at least eight percent of total risk weighted assets (RWA). This requirement is further decomposed into Common Equity Tier 1 capital, Additional Tier 1 capital and Tier 2 capital requirements.<sup>141</sup> Common Equity Tier 1 capital consists of common shares issued by the bank, share premiums, retained earnings and common shares issued by subsidiaries of the bank. Additional Tier 1 capital consists of many of the same element as Common Equity Tier 1 capital, but the requirements for qualifying for Additional Tier 1 capital is milder. In general, the different regulatory capital items are evaluated from their loss absorbency. Tier 2 capital consists of those items that meet the Tier 2 capital requirements as outlined in the global Basel III framework, and that are not included in the Tier 1 capital definition.<sup>142</sup>

Specifically, banks must hold an amount of Tier 1 capital equal to 6 percent of their total risk-weighted assets. Of these 6 percent, at least 4,5 percentage points must consist of Common Equity Tier 1 capital. Banks can also turn towards Tier 2 capital, which can then at maximum make up 2 percentage points of the total 8 percent of the total risk-weighted assets.<sup>143</sup>

In order to control for bank's potential accommodation for the capital requirements, we do the following. We include a variable expressing the yearly changes in the Tier 1 capital ratio of a given bank. The Tier 1 capital consists of Common Equity Tier 1 capital and Additional Tier 1 capital.

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<sup>140</sup> Banking Committee on Banking Supervision, *Basel III: Revised Basel III leverage ratio framework and disclosure requirements*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), June 2013, Page 5.

<sup>141</sup> Banking Committee on Banking Supervision, *Basel III: A global regulatory framework for more resilient banks and banking systems*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), June 2011, Page 12.

<sup>142</sup> Banking Committee on Banking Supervision, *Basel III: A global regulatory framework for more resilient banks and banking systems*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), June 2011, Pages 12 -19.

<sup>143</sup> Banking Committee on Banking Supervision, *Basel III: A global regulatory framework for more resilient banks and banking systems*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), June 2011, Page 12.

Second, we include a variable expressing the yearly changes in the Tier 2 capital ratio of a given bank. Thirdly, we include a variable expressing the yearly changes in a bank's total capital ratio, where the total capital ratio is the sum of Tier 1 capital and Tier 2 capital- All of these sums are divided by the total risk-weighted assets in order to obtain the capital ratio.

As with the other liquidity requirements, we also include variables that expresses the potential gaps towards the minimum capital requirements. As outlined above, the minimum requirement for Tier 1 capital to total risk-weighted assets is 6 percent. In order to construct a variable expressing the potential gap towards this target in the previous period, we subtract the last period's Tier 1 capital ratio from the target of 6 percent. This procedure is used for the Tier 2 capital ratio as well as the total capital ratio. For these requirements, the targets will be 2 percent and 8 percent respectively. It should be noted however, that the Tier 2 capital does not have a target of 2%, since it can be substituted by Tier 1 capital.

$$\Delta \text{Tier 1 Capital Ratio}_{i,t} = \text{Tier 1 Capital Ratio}_{i,t} - \text{Tier 1 Capital Ratio}_{i,t-1}$$

$$\Delta \text{Tier 2 Capital Ratio}_{i,t} = \text{Tier 2 Capital Ratio}_{i,t} - \text{Tier 2 Capital Ratio}_{i,t-1}$$

$$\Delta \text{Total Capital Ratio}_{i,t} = \text{Total Capital Ratio}_{i,t} - \text{Total Capital Ratio}_{i,t-1}$$

$$\text{Lagged Tier 1 Capital Ratio Deficit}_{i,t} = 0,06 - \text{Tier 1 Capital Ratio}_{i,t-1}$$

$$\text{Lagged Tier 2 Capital Ratio Deficit}_{i,t} = 0,02 - \text{Tier 2 Capital Ratio}_{i,t-1}$$

$$\text{Lagged Total Capital Ratio Deficit}_{i,t} = 0,08 - \text{Total Capital Ratio}_{i,t-1}$$

It turns out, however, that the  $\Delta \text{Tier 2 Capital Ratio}_{i,t}$  variable as well as the  $\text{Lagged Tier 2 Capital Ratio Deficit}_{i,t}$  are in-significant across regressions. Furthermore, it turns out that the remaining four capital ratio variables are perfectly explained by the yearly changes in the previously outlined Leverage Ratio control variables. This means that the yearly changes in the LR and the yearly changes in the capital ratios are very closely correlated. The result from this is that the capital ratio variables as explanatory variables are basically contained in the LR control variables and thereby cannot provide any additional explanatory power. When we include the capital ratio variables together with the yearly changes in the LR and the Lagged LR Deficit, all of the capital ratio variables turn out to be insignificant. According to these results, we will only include the yearly changes in the LR and the Lagged LR Deficit since these will implicitly account for the minimum capital requirements.

### 6.3.7 Year Specific Dummy Variables

As we are sampling across the time period of 2009 to 2014, we capture the aftermath of the financial crisis as well as the onset of the recovery of the global economy. The fact that the six years in our sample are quite different in terms of year specific effects, it seems reasonable to include time dummy variables in our regressions. These effects could be e.g. changes in the financial market conditions or the macroeconomic landscape. When including the time dummy variables, we cannot use 2009 as a base year. This is due to the fact that we include variables measured as yearly changes and lagged explanatory variables. Therefore, we use 2010 as the base year and include time dummy variables for 2011, 2012, 2013 and 2014.

However, when we include time dummies together with macroeconomic control variables that are sampled on a yearly basis, an issue of perfect multicollinearity arise. The issue is that the U.S. CPI, the real GDP growth rate and the interest rate will appear with the same value for every bank in the same year. The result from this is that they can be perfectly replicated as linear combinations of the time dummy variables. In order to assess whether inclusion of time dummy variables or macroeconomic control variables would produce the most feasible model, we have conducted a series of F-tests for model reduction.<sup>144</sup> The results of these tests points towards the inclusion of time dummy variables, as the models with macroeconomic control are inferior to the time dummy models. This means that the explanatory power of the macroeconomic control variables is perfectly captured by the information contained in the time dummy variables. Furthermore, the models with macroeconomic control yields higher p-values as well as lower adjusted coefficients of determination, which further indicates the inferiority of including the macroeconomic control variables. According to these results, it seems that the time dummy variables can capture the variation in the macroeconomic landscape across the time window of our sample. The issue of excluding the macroeconomic variables is the lack of knowledge about the specific drivers for structural changes across the different years. However, since the focus of our analysis is to find potential drivers of the yearly changes in the NSFR, the exact macroeconomic reasons are not crucially important. It is only necessary to control for their effect implicitly via our time dummy variables in order to net out their effect from the other parameter estimates in our model.

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<sup>144</sup> An example of this model test can be seen in Appendix 3 :*Test for Macro Variable Exclusion*.



## 6.4 The Panel Data Regression Model

In order to test our hypotheses, we will regress the yearly changes in each of our selected balance sheet items against the yearly changes in the NSFR together with ten different control variables. Each balance sheet item will be expressed as a ratio to total assets or total liabilities depending on its position on the balance sheet. The control variables comprise the liquidity requirements, the total asset variable and the four time dummies. As mentioned earlier, fixed effect estimation proved to be the most proper estimator. This implies that our model will contain a single error term,  $u_{i,t}$ , that is assumed to be uncorrelated with the eleven explanatory variables. Furthermore, as outlined earlier, the bank-specific demeaning procedure for fixed effect OLS estimation will eliminate the constant in our model. Thereby our final model for hypothesis testing will take the following form.

$$\begin{aligned} \Delta \text{Ratio of Balance Sheet Item to Total Assets or Total Liabilities}_{i,t} \\ = \beta_1 \Delta \text{NSFR}_{i,t} + \beta_2 \text{Lagged NSFR Deficit}_{i,t} + \beta_3 \Delta \text{LCR}_{i,t} + \beta_4 \text{Lagged LCR Deficit}_{i,t} \\ + \beta_5 \Delta \text{LR}_{i,t} + \beta_6 \text{Lagged LR Deficit}_{i,t} + \beta_7 \text{Total Assets}_{i,t} + \beta_8 \text{Dummy2011}_{i,t} \\ + \beta_9 \text{Dummy2012}_{i,t} + \beta_{10} \text{Dummy2013}_{i,t} + \beta_{11} \text{Dummy2014}_{i,t} + u_{i,t} \end{aligned}$$

The purpose of the model is to evaluate the significance and sign of the parameter estimate of the explanatory variable expressing the yearly changes in the NSFR,  $\beta_1$ . Upon observation of a significant estimate, it can be concluded that when the NSFR of a given bank is changed, it will be associated with a significant linear change in the ratio of the given balance sheet item on the left-hand side. Due to the fact that multiple factors might be driving the ratio of the balance sheet item, it will not be possible to guarantee causality. The issue is that we cannot test whether the balance sheet item on the left-hand side was changed in order to specifically adjust the NSFR. However, we can move as close to causality as possible by comparing the findings from the regression with the outcome that would be expected, if the ratio of the given balance sheet item were changed with the purpose of NSFR compliance. If it is possible to establish a match, then it is at least possible that the changes in the balance sheet item are partly driven by NSFR considerations. This conclusion can be drawn since an increase in the NSFR does not require a change in the ratio of a given balance sheet item. In the case where the predicted sign of a parameter estimate does not match with the sign evident from the regression results, we will have to investigate other underlying effects.

The regression modeling is based on a reduction procedure. We initiate all estimations by regressing the yearly change in the ratio of a particular balance sheet item onto the 11 explanatory

variables as outlined above. A reduced model is constructed in a stepwise manner from the full model. The term *reduced model* will be used to indicate that the given model only includes variables that are significant at a 5% significance level. The procedure starts by eliminating that of the insignificant explanatory variables from the full model that yields the highest p-value. This procedure continues until all of the parameter estimates of the remaining explanatory variables yield p-values below the significance threshold of 5%. Specifically, we will use a regular double-sided t-test in order to test the significance of each parameter estimate. Each estimate will be tested under the following set of hypotheses.

$$H_0: \beta_j = 0$$

$$H_1: \beta_j \neq 0$$

The magnitude of the parameter estimates will show how large an adjustment a bank on average would have to make in the ratio of a given balance sheet item in order to see a 100 percentage point increase in the NSFR. A 100 percentage point increase in the NSFR is dramatic, and a more meaningful interpretation could be obtained by using something less than a full unit increase. However, the magnitude interpretation is not important for our hypothesis testing and will only serve as an additional insight.

Even though we have applied a demeaning procedure in order to eliminate the unobserved bank-specific effects from our models we can still capture structural shifts in the yearly ratio changes of our selected balance sheet items. However, the interpretation of the parameter estimates for the time dummy variables is difficult. If a time dummy variable estimate is significant it will show a structural year-based shift in the change in the ratio of the given balance sheet item. Hence, the signs and magnitudes of the time dummy variables does not express a level change in the stock of the given balance sheet item. Instead, they express a structural increase or decrease in the yearly changes in the ratio of a given balance sheet item. As an example, we can take a given bank and assume that we observe a significant and positive time dummy variable for the year 2014. This means that this bank would have a constant term added to its yearly change in the ratio of the given balance sheet item, if the NSFR were to increase by one unit. In this way, the changes in the ratio of the balance sheet item would on average be more positive across all banks. Let us furthermore assume that this bank in 2010 would show an increase in the ratio of the given balance sheet item, following a one unit NSFR increase. If the observation values across all of this bank's characteristics are the same in 2014, this bank would now show an even larger increase in the ratio

of the given balance sheet item if the NSFR were to increase by one unit. This means that the bank would have to increase the ratio of the balance sheet item more in 2014 as compared to 2010 in order to see a one unit increase in its NSFR. However, we do not know of the baseline level of the yearly changes in the ratios and for this reason we cannot make these interpretations. But, these time dummy variable interpretations are not necessary for our hypothesis testing. The important thing is that we manage to control for these time based effects across our sample.

Many of the variables in our model will have different units of measurement. The unit of measurement on our bank size control variable, total assets, is 1000 USDs. The entire set of variables that are calculated as yearly changes in ratios will be denoted on a percentage point basis. This means that a one unit increase will correspond to a 100 percentage point increase. The lagged deficit variables are measured in percentage point gaps, where a one unit increase corresponds to a 100 percentage point increase in the given deficit. Lastly, the constructed response variables will be denoted as yearly changes in ratios and are measured in percentage points as well.

| Variable  | Type                 | Unit of Measurement      |
|---|----------------------|--------------------------|
| Delta of Ratio of Balance Sheet Item to Total Assets or Total Liabilities | Response Variable    | Percentage Points        |
| Delta NSFR  | Explanatory Variable | Percentage Points        |
| Lagged NSFR Deficit   | Explanatory Variable | Gap in Percentage Points |
| Delta LCR   | Explanatory Variable | Percentage Points        |
| Lagged NSFR Deficit   | Explanatory Variable | Gap in Percentage Points |
| Delta LR  | Explanatory Variable | Percentage Points        |
| Lagged LR Deficit   | Explanatory Variable | Gap in Percentage Points |
| Total Assets  | Explanatory Variable | 1000 USD (Level Based)   |
| 2011 Dummy  | Explanatory Variable | Percentage Points        |
| 2012 Dummy  | Explanatory Variable | Percentage Points        |
| 2013 Dummy  | Explanatory Variable | Percentage Points        |
| 2014 Dummy  | Explanatory Variable | Percentage Points        |

Table 6.4: Units of measurement for the variables specified in the panel data regression model.

## 7. Hypothesis Testing

This section contains the testing and analysis of the eight previously outlined hypotheses. The overall focus is to determine which balance sheet items that are significant drivers of the NSFR and evaluate whether an NSFR relevant behaviour is evident in the regression results for each of these potential drivers. The hypotheses will be tested and evaluated one by one in the same order as outlined in section 3.2 on hypothesis rationales. Each balance sheet item will be represented in different editions when they are constructed as a response variable for the regression analysis. As outlined in section 6 on the choice of econometric model, the following regression model will be applied for each single response variable.

$$\begin{aligned} \Delta \text{Ratio of Balance Sheet Item to Total Assets or Total Liabilities}_{i,t} \\ = \beta_1 \Delta \text{NSFR}_{i,t} + \beta_2 \text{Lagged NSFR Deficit}_{i,t} + \beta_3 \Delta \text{LCR}_{i,t} + \beta_4 \text{Lagged LCR Deficit}_{i,t} \\ + \beta_5 \Delta \text{LR}_{i,t} + \beta_6 \text{Lagged LR Deficit}_{i,t} + \beta_7 \text{Total Assets}_{i,t} + \beta_8 \text{Dummy2011}_{i,t} \\ + \beta_9 \text{Dummy2012}_{i,t} + \beta_{10} \text{Dummy2013}_{i,t} + \beta_{11} \text{Dummy2014}_{i,t} + u_{i,t} \end{aligned}$$

A full overview of the construction of the response variables based on Call Report accounting codes is illustrated in table 7 on the following page. This table outlines the items extracted from the Call Reports in order to construct each single response variable for the eight hypotheses.

| Hypothesis           | Variable                        | Sub-Variable         | Call Report RCON Code |          |          |          |
|----------------------|---------------------------------|----------------------|-----------------------|----------|----------|----------|
| Hypothesis 1         | Total Securities                | Securities 0%        | RCONB604              | RCONB609 |          |          |
|                      |                                 | Securities 20%       | RCONB605              | RCONB610 |          |          |
|                      |                                 | Securities 50%       | RCONB606              | RCONB611 |          |          |
|                      |                                 | Securities 100%      | RCONB607              | RCONB612 |          |          |
| Hypothesis 2         | Security Risk Weight Categories | Securities 0%        | RCONB604              | RCONB609 |          |          |
|                      |                                 | Securities 20%       | RCONB605              | RCONB610 |          |          |
|                      |                                 | Securities 50%       | RCONB606              | RCONB611 |          |          |
|                      |                                 | Securities 100%      | RCONB607              | RCONB612 |          |          |
| Hypothesis 3         | Total Deposits                  | Time Dep. >1yr       | RCONA581              | RCONA582 | RCONA586 | RCONA587 |
|                      |                                 | Small Time Dep. <1yr | RCONA241              |          |          |          |
|                      |                                 | Large Time Dep. <1yr | RCONK221              | RCONK222 |          |          |
|                      |                                 | Retail Trans. Dep.   | RCONB549              |          |          |          |
|                      |                                 | Retail Savings Dep.  | RCON6810              | RCON0352 |          |          |
|                      |                                 | Wholes. Trans. Dep.  | RCONB549              |          |          |          |
|                      |                                 | Wholes. Savings Dep. | RCON6810              | RCON0352 |          |          |
|                      |                                 | Foreign Dep.         | RCON2213              | RCON2236 |          |          |
|                      |                                 | Trans. Dep. US       | RCON2202              |          |          |          |
|                      |                                 | Trans. Dep. States   | RCON2203              |          |          |          |
| Hypothesis 4         | Wholesale Deposits              | Wholes. Trans. Dep.  | RCONB549              |          |          |          |
|                      |                                 | Wholes. Savings Dep. | RCON6810              | RCON0352 |          |          |
|                      | Transaction Deposits            | Trans. Dep. US       | RCON2202              |          |          |          |
|                      |                                 | Trans. Dep. States   | RCON2203              |          |          |          |
|                      |                                 | Trans. Dep. Foreign  | RCON2216              |          |          |          |
|                      | Foreign Dep.                    | Foreign Dep.         | RCON2213              | RCON2236 |          |          |
|                      | Time Dep. >1yr                  | Time Dep. >1yr       | RCONA581              | RCONA582 | RCONA586 | RCONA587 |
|                      | Small Time Dep. <1yr            | Small Time Dep. <1yr | RCONA241              |          |          |          |
| Large Time Dep. <1yr | Large Time Dep. <1yr            | RCONK221             | RCONK222              |          |          |          |
| Hypothesis 5         | Total Derivatives               | Held for Trading     | RCONA126              | RCONA127 | RCON8723 | RCON8724 |
|                      |                                 | Other Purposes       | RCON8725              | RCON8726 | RCON8727 | RCON8728 |
| Hypothesis 6         | Total HQLA                      | Cash                 | RCON0081              | RCON0071 |          |          |
|                      |                                 | Securities 0%        | RCONB604              | RCONB609 |          |          |
|                      |                                 | Securities 20%       | RCONB605              | RCONB610 |          |          |
| Hypothesis 7         | Total Lending                   | Loans 0%             | RCONB618              | RCONB623 |          |          |
|                      |                                 | Loans 20%            | RCONB619              | RCONB624 |          |          |
|                      |                                 | Loans 50%            | RCONB620              | RCONB625 |          |          |
|                      |                                 | Loans 100%           | RCONB621              | RCONB626 |          |          |
| Hypothesis 8         | Loan in Risk W.                 | Loans 0%             | RCONB618              | RCONB623 |          |          |
|                      |                                 | Loans 20%            | RCONB619              | RCONB624 |          |          |
|                      |                                 | Loans 50%            | RCONB620              | RCONB625 |          |          |
|                      |                                 | Loans 100%           | RCONB621              | RCONB626 |          |          |
| Total Assets         |                                 |                      | RCON3368              |          |          |          |

Table 7: Overview of the response variable construction based on Call Report accounting codes.

## 7.1 Test of the Securities Hypotheses

### Hypothesis 1

*“Banks’ adjustment of the ratio of total securities to total assets is a significant driver of the yearly changes in the NSFR”*

### Hypothesis 2

*“Banks’ adjustment of their ratios of low-risk and high-risk securities to total assets is a significant driver of the yearly changes in the NSFR”*

### Hypothesis Regression Setup

To test hypotheses 1 we construct a response variable that expresses the yearly changes in the ratio of total securities to total assets.

$$\Delta \text{Ratio of Securities To Total Assets}_{i,t} = \Delta \frac{\text{Total Securities}_{i,t}}{\text{Total Assets}_{i,t}} = \frac{\text{Total Securities}_{i,t}}{\text{Total Assets}_{i,t}} - \frac{\text{Total Securities}_{i,t-1}}{\text{Total Assets}_{i,t-1}}$$

In the interest of additional insights we also construct a response variable measuring the yearly changes in the level of the total stock of securities.

$$\Delta \text{Total Securities}_{i,t} = \text{Total Securities}_{i,t} - \text{Total Securities}_{i,t-1}$$

In order to test hypothesis 2 we construct a response variable expressing the yearly changes in the ratio of each security type to total assets for each of the four risk-weight segmented security types.

$$\Delta \text{Ratio of Security Type } j_{i,t} = \Delta \frac{\text{Amount of Security Type } j_{i,t}}{\text{Total Assets}_{i,t}} \quad \text{for } j = 1, \dots, 4$$

$$\Delta \text{Ratio of Security Type } j_{i,t} = \frac{\text{Amount of Security Type } j_{i,t}}{\text{Total Assets}_{i,t}} - \frac{\text{Amount of Security Type } j_{i,t-1}}{\text{Total Assets}_{i,t-1}}$$

The  $j$  operator denotes securities with 0%, 20%, 50% and 100% risk weights respectively. The exact regression model that will be examined for both hypotheses takes the following form.

$$\begin{aligned} \Delta \text{Ratio of Balance Sheet Item to Total Assets}_{i,t} &= \beta_1 \Delta \text{NSFR}_{i,t} + \beta_2 \text{Lagged NSFR Deficit}_{i,t} + \beta_3 \Delta \text{LCR}_{i,t} + \beta_4 \text{Lagged LCR Deficit}_{i,t} \\ &+ \beta_5 \Delta \text{LR}_{i,t} + \beta_6 \text{Lagged LR Deficit}_{i,t} + \beta_7 \text{Total Assets}_{i,t} + \beta_8 \text{Dummy2011}_{i,t} \\ &+ \beta_9 \text{Dummy2012}_{i,t} + \beta_{10} \text{Dummy2013}_{i,t} + \beta_{11} \text{Dummy2014}_{i,t} + u_{i,t} \end{aligned}$$

In the following output table, model (1) and (2) represent a full and a reduced<sup>145</sup> regression model for the response variable  $\Delta \text{Total Securities}_{i,t}$ . Model (3) denotes a reduced regression model for the response variable  $\Delta \text{Ratio of Securities To Total Assets}_{i,t}$ . Models (4), (5), (6) and (7) represent reduced models for the four types of security response variables,  $\Delta \text{Ratio of Security Type } j_{i,t}$ .

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<sup>145</sup> The term reduced is used to indicate that the given model only includes explanatory variables that have turned out to yield parameter estimates that are significant at a 5% significance level. A reduced model is constructed by eliminating that of the insignificant explanatory variables from the full model that yields the highest p-value, if of course there are any insignificant variables. This procedure continues until all the parameter estimates of the remaining explanatory variables yield p-values below the threshold of 5%.

|                         | <i>Dependent variable:</i>   |                              |   |                               |                                |                                |                                 |
|-------------------------|------------------------------|------------------------------|---|-------------------------------|--------------------------------|--------------------------------|---------------------------------|
|                         | Delta of Total Securities    |                              | Delta Ratio of Securities To Total Assets | Delta Ratio of 0RW Securities | Delta Ratio of 20RW Securities | Delta Ratio of 50RW Securities | Delta Ratio of 100RW Securities |
|                         | (1)                          | (2)                          | (3)                                       | (4)                           | (5)                            | (6)                            | (7)                             |
| Delta NSFR              | 864,467.4***<br>(245,037.8)  | 848,742.2***<br>(165,911.5)  | 0.1548***<br>(0.0225)                     |                               | 0.1247***<br>(0.0169)          | 0.0103*<br>(0.0053)            | -0.0204***<br>(0.0078)          |
| Lagged NSFR Deficit     | 36,798.7<br>(246,994.4)      |                              | -0.0729***<br>(0.0232)                    |                               |                                | -0.0110**<br>(0.0056)          | -0.0180**<br>(0.0082)           |
| Delta LCR               | -28,676.26<br>(78,278.66)    |                              |   | 0.0052*<br>(0.0028)           |                                |                                |                                 |
| Lagged LCR Deficit      | 45,855.75<br>(82,153.06)     |                              |   |                               |                                |                                |                                 |
| Delta LR                | -9,831,214***<br>(1,311,028) | -9,852,718***<br>(1,217,295) |   |                               |                                |                                |                                 |
| Lagged LR Deficit       | 9,573,291***<br>(1,358,831)  | 9,558,846***<br>(1,247,494)  |   |                               |                                |                                |                                 |
| Total Assets            | 0.0075<br>(0.0125)           |                              |   |                               |                                |                                |                                 |
| 2011 Dummy              | 22,740.83<br>(48,017.41)     |                              |   | -0.0133***<br>(0.0025)        | 0.0118***<br>(0.0035)          |                                |                                 |
| 2012 Dummy              | -8,210.993<br>(50,394.54)    |                              | -0.0175***<br>(0.0038)                    | -0.0147***<br>(0.0025)        |                                |                                |                                 |
| 2013 Dummy              | 18,325<br>(56,782.35)        |                              | -0.0103***<br>(0.0038)                    | -0.0121***<br>(0.0025)        |                                |                                |                                 |
| 2014 Dummy              | -41,371.84<br>(63,095.18)    |                              | -0.0266***<br>(0.0039)                    | -0.0130***<br>(0.0025)        | -0.0118***<br>(0.0035)         |                                | -0.0030**<br>(0.0013)           |
| Observations            | 765                          | 765                          | 805                                       | 805                           | 805                            | 805                            | 805                             |
| R <sup>2</sup>          | 0.1564                       | 0.1524                       | 0.1588                                    | 0.0732                        | 0.1177                         | 0.0073                         | 0.0534                          |
| Adjusted R <sup>2</sup> | 0.1212                       | 0.1197                       | 0.1261                                    | 0.0581                        | 0.0937                         | 0.0058                         | 0.0425                          |
| F Statistic             | 9.9949***<br>(df =11;593)    | 36.0185***<br>(df =3; 601)   | 24.1330***<br>(df = 5; 639)               | 10.0972***<br>(df = 5; 639)   | 28.5001***<br>(df = 3; 641)    | 2.3543*<br>(df = 2; 642)       | 12.0603***<br>(df = 3; 641)     |

Note:

\* p<0.1; \*\* p<0.05; \*\*\* p<0.01

Method: Panel Data Regression with Fixed Effects Estimation

Table 7.1: Panel data regression output for hypotheses 1 and 2.

The first insight that can be extracted from the regression output table is the significant and positive parameter estimate of the Delta NSFR variable in model (2) and (3). Specifically, the positive and significant estimate of the Delta NSFR variable in model (2) shows that the total stock of securities



has been increased significantly in periods where the NSFR has increased. By interpreting model (3) it can be seen that banks are increasing the ratio of total securities to total assets when the NSFR is increased. In a strict NSFR consideration perspective this finding is counterintuitive. Securities are penalized rather hard regardless of their risk-weighting as compared to other asset types on a bank's balance sheet. It would be expected that the ratio of total securities to total assets should go down as positive changes in the Delta NSFR are encountered. More precisely, the segmentation of securities in risk-weighting categories of 0%, 20%, 50% and 100% are assigned RSF factors of respectively 5%, 15%, 50% and 100%. This indicates the theoretical NSFR decline that would be expected when the ratio of total securities held on the balance sheet is increased. One of the reasons for this counterintuitive observation might be the fact that banks are focusing on a large variety of other issues than NSFR compliance. An indication of this is seen from the negative and significant sign of the Delta LR variable in model (2). This indicates that in periods where banks have increased their ratio of total securities to total assets, it has on average been associated with a significant decrease in the LR. Conversely, in periods where banks have decreased their ratio of total securities to total assets, this has on average been associated with a significant increase in the LR. We cannot conclude if this behavior is strictly LR relevant or whether it serves the purpose of multiple objectives. However, it indicates that banks indeed are pursuing other objectives than NSFR compliance. This might be able to partly explain why we observe significant NSFR increases as a function of increases in the total stock or the ratio of securities, even though this sign is opposite to our expectation.

In addition to the LR argument, there will likely exist other reasons for the positive sign on the Delta NSFR variable in model (2) and (3). First, the negative RSF effect from increases in the ratio of total securities to total assets can be offset by relying less on other asset types that are assigned even higher RSF factors. Derivatives would be an example of such an asset type. Second, the positive sign might also occur if the increases in the stock or ratio of total securities has been funded by liability items treated sufficiently favorably in terms of ASF factor allocation. We cannot provide an exact conclusion to the underlying reason for the positive sign. However, we can verify hypothesis 1 due to the significant parameter estimate of the Delta NSFR variable in model (3). Thereby, the ratio of total securities to total assets proves to be a significant driver of the yearly changes in the NSFR.

A more intuitive finding is the negative and significant parameter estimate of the Lagged NSFR Deficit variable in model (3). An increase in the Lagged NSFR Deficit variable would lead to a

decrease in a bank's ratio of total securities to total assets in the following period. In this way, when banks are increasing their ratio of total securities to total assets, this will increase the RSF denominator of the NSFR and thereby decrease the overall measure. This would then increase the distance to the NSFR target of 1. As our data sample is based on year-end observations, the lagged deficit denotes the distance to the NSFR target of 1 at the onset of the current period. The lagged NSFR deficit thereby closely tracks a potential incentive to increase the NSFR by adjusting the ratio of total securities to total assets in the following period.

Interpretation of the parameter estimates for the time dummy variables is challenging. As a starting point, 2010 is the dummy baseline year for our regression model. This means that 2010 is captured as a fixed level from which the year-specific differences in other years are calculated. If one then observes a negative and significant parameter estimate for one of the time dummy variables in the model, this expresses a constant difference to the baseline year. This would mean that in this particular year, one would have to subtract a constant amount from the yearly change in the ratio total securities to total assets. We can take model (3) as an example. If the yearly change in the ratio of total securities to total assets is negative in the baseline year 2010, a negative dummy parameter estimate for a given year will indicate that the yearly change in the security ratio is more negative in that year. If the change in the ratio of total securities is positive in the baseline year, a negative dummy parameter indicates that the difference is less positive in the given year. From model (3) it can then be seen that the yearly changes in the ratio of total securities is less positive in the dummy years 2012, 2013, and 2014, as compared to 2010. However, the exact interpretation of the time dummy variables is not important. The important and interesting thing is the presence of a potential structural shift, and that the year-specific effects across the sampling window has been netted out of the other parameter estimates in the models.

We will have to reject our suspicion that the parameter estimate of the Delta NSFR variable in model (3) would be negative. There is no evidence that banks are reducing their ratio of total securities to total assets as a tool to improve their NSFRs. Instead, banks are actually increasing the ratio of total securities to total assets in periods where the NSFR is improved. This indicates that other objectives than strict NSFR compliance will play a role when banks decide on their ratios of securities to total assets. As mentioned earlier, a potential explanation could be that the negative RSF effect from the increase in the ratio of total securities is offset by other balance sheet adjustments. It could be the case that the increase in securities is funded by sufficiently high ASF weighted liabilities. However, a third possibility is an internal shift across security types. If the ratio

of high RSF-weighted securities is decreased, while the ratio of low RSF-weighted securities is increased, the NSFR can be improved despite an overall increase in the ratio of securities. This suspicion leads towards the testing of hypothesis 2.

According to hypothesis 2 we would expect the Delta NSFR parameter estimate to be e.g. positive for the 0% risk-weighted and 20% risk-weighted securities (model (4) and model (5)), and negative for the 50% risk-weighted and 100% risk-weighted security types (model (6) and model (7)). The reason for this is the higher RSF factors that are assigned to more risky security types. In fact, many different combinations of upwards and downwards adjustment of the ratios of the different security types can indicate NSFR relevant behavior. Verification of any of these combinations could indicate that banks are using the ratios of their different security types as a tool for NSFR compliance.

In order to investigate the adjustment pattern of the security types we can evaluate the parameter estimates of the Delta NSFR variable in models (4) to (7). The insignificance of the Delta NSFR parameter estimate in model (4) indicates that the yearly changes in a bank's NSFR are not on average associated with a significant adjustment of the ratio of 0% risk-weighted securities to total assets. For the remaining three models, the signs and significance aligns with the expectation if the adjustments were to be NSFR relevant. Yearly NSFR increases are on average associated with a decrease in the ratio of 100% risk-weighted securities and increases in the ratios of 20% risk-weighted and 50% risk-weighted securities. This indicates that banks are on average shifting from high-risk to low-risk securities and this behavior matches a pattern that could be NSFR relevant. Thereby, adjustments of the ratios of different security types might serve as a used-in-practice tool for NSFR compliance.

Investigation of the LCR and LR parameters in model (4) through (7) indicates that these do not play a significant role in the adjustment of the ratios of different security types, except for the 0% risk-weighted securities. A positive and significant LCR estimate is found for model (4), which is not surprising as securities with a risk-weight of 0% are contained in the HQLA numerator of the LCR<sup>146</sup>. We cannot state direct causality, however, as the Delta LCR variable is significant and has a positive sign it at least indicates that the ratio of 0% risk-weighted securities to total assets could serve as a tool for LCR compliance. It is worth highlighting that the empirical evidence from model (4) suggests that the ratio of 0% risk-weighted securities is of greater relevance for LCR compliance

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<sup>146</sup> Refer to the Call Report allocation table (Table 5.2 (iv)) in section 5.2.

than for NSFR compliance. This is indicated by the difference in significance between the parameter estimates on the Delta NSFR variable and the Delta LCR variable.

The pattern that is observed for the Delta NSFR variables in models (4) to (7) verifies hypothesis 2. Thereby, banks' adjustment of their ratios of the different security types is a significant driver of the yearly changes in the NSFR.

## 7.2 Test of the Deposit Hypotheses

### Hypothesis 3

*"Banks' adjustment of the ratio of total deposits to total liabilities is a significant driver of the yearly changes in the NSFR"*

### Hypothesis 4

*"Banks' adjustment of their ratios of low-risk and high-risk deposit types to total liabilities is a significant driver of the yearly changes in the NSFR"*

### Hypothesis Regression Setup

In order to test hypothesis 3 we will construct a variable that expresses the yearly changes in a bank's ratio of total deposits to total liabilities. Total deposits is comprised of a range of different deposit types that we have allocated to six main deposit categories based on Call Report segmentations.<sup>147</sup> These categories are long-term time deposits, short-term large time deposits, short-term small time deposits, transaction deposits, foreign deposits and wholesale deposits. In order to investigate the relation between the yearly changes in a bank's NSFR and the yearly changes in the ratio of total deposits to total liabilities we construct a response variable as follows.

$$\Delta \text{Ratio of Total Deposits to Total Liabilities}_{i,t} = \frac{\text{Total Deposits}_{i,t}}{\text{Total Liabilities}_{i,t}} - \frac{\text{Total Deposits}_{i,t-1}}{\text{Total Liabilities}_{i,t-1}}$$

In the interest of additional insight we also construct a response variable that expresses the yearly changes in a bank's total stock of deposits.

$$\Delta \text{Total Deposits}_{i,t} = \text{Total Deposits}_{i,t} - \text{Total Deposits}_{i,t-1}$$

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<sup>147</sup> We have ensured that only deposit types of similar ASF weighting have been categorized together. I.e. deposit types that are allocated a 30 percent ASF factor, have been categorized together. The only exception is the wholesale and retail deposits that are pooled together in the same variable in the Call Reports. However, a split up of these based on an assumption would yield two columns that are perfectly dependent and would therefore give the same regression results. In this way, it does not matter whether wholesale deposits and retail deposits are split or pooled.

To test hypothesis 4 we construct six different response variables expressing the yearly changes in the ratios of each deposit category to total liabilities.

$$\Delta \text{ Ratio of Deposit Category } j_{i,t} = \Delta \frac{\text{Amount of Deposit Category } j_{i,t}}{\text{Total Liabilities}_{i,t}} \text{ for } j = 1, \dots, 6$$

$$\Delta \text{ Ratio Of Deposit Category } j_{i,t} = \frac{\text{Amount of Deposit Category } j_{i,t}}{\text{Total Liabilities}_{i,t}} - \frac{\text{Amount of Deposit Category } j_{i,t-1}}{\text{Total Liabilities}_{i,t-1}}$$

The exact regression model that will be examined for hypothesis 3 takes the following form.

$$\begin{aligned} \Delta \text{Ratio of Total Deposits to Total Liabilities}_{i,t} \\ = \beta_1 \Delta \text{NSFR}_{i,t} + \beta_2 \text{Lagged NSFR Deficit}_{i,t} + \beta_3 \Delta \text{LCR}_{i,t} + \beta_4 \text{Lagged LCR Deficit}_{i,t} \\ + \beta_5 \Delta \text{LR}_{i,t} + \beta_6 \text{Lagged LR Deficit}_{i,t} + \beta_7 \text{Total Assets}_{i,t} + \beta_8 \text{Dummy2011}_{i,t} \\ + \beta_9 \text{Dummy2012}_{i,t} + \beta_{10} \text{Dummy2013}_{i,t} + \beta_{11} \text{Dummy2014}_{i,t} + u_{i,t} \end{aligned}$$

For the testing of hypothesis 4 we will conduct six separate regressions. One for each of the six different deposit types. In the following output table model (1) and (2) represents a full and a reduced regression model for the response variable  $\Delta \text{ Total Deposits}_{i,t}$ . Model (3) denotes a reduced regression model for the response variable  $\Delta \text{ Ratio of Total Deposits to Total Liabilities}_{i,t}$ . The regression output for hypothesis 3 is shown in table 7.2 (i) on the following page.

|                         | <i>Dependent variable:</i>                |   |   |
|-------------------------|---|---|---|
|                         | Delta of Total Deposits                   |   | Delta Ratio of Total Deposits<br>To Total Liabilities |
|                         | (1)                                       | (2)                                       | (3)   |
| Delta NSFR              | 1,544,666 <sup>***</sup><br>(483,464.3)   | 1,397,839 <sup>***</sup><br>(364,857.2)   | 0.0176<br>(0.0191)                                    |
| Lagged NSFR Deficit     | -214,912.6<br>(487,324.6)                 |   |   |
| Delta LCR               | -401,271 <sup>**</sup><br>(154,445.3)     | -403,140.3 <sup>***</sup><br>(144,821.1)  |   |
| Lagged LCR Deficit      | 379,436.3 <sup>**</sup><br>(162,089)      | 383,467.3 <sup>***</sup><br>(140,648.7)   | -0.0123 <sup>**</sup><br>(0.0055)                     |
| Delta LR                | -28,294,406 <sup>***</sup><br>(2,586,684) | -28,173,441 <sup>***</sup><br>(2,559,527) | 0.0392<br>(0.0349)                                    |
| Lagged LR Deficit       | 27,363,293 <sup>***</sup><br>(2,680,999)  | 27,127,576 <sup>***</sup><br>(2,640,578)  |   |
| Total Assets            | 0.2212 <sup>***</sup><br>(0.0247)         | 0.2232 <sup>***</sup><br>(0.0237)         | 0.0000 <sup>*</sup><br>(0.0000)                       |
| 2011 Dummy              | 339,307.7 <sup>***</sup><br>(94,739.26)   | 303,867.8 <sup>***</sup><br>(74,935.49)   | 0.0645 <sup>***</sup><br>(0.0051)                     |
| 2012 Dummy              | 56,351.37<br>(99,429.4)                   |   | -0.0139 <sup>***</sup><br>(0.0051)                    |
| 2013 Dummy              | -176,769.7<br>(112,032.7)                 | -216,975.9 <sup>***</sup><br>(80,212.6)   | -0.0287 <sup>***</sup><br>(0.0056)                    |
| 2014 Dummy              | -160,392<br>(124,488)                     | -207,419 <sup>**</sup><br>(89,755.76)     | -0.0296 <sup>***</sup><br>(0.0062)                    |
| Observations            | 765                                       | 765                                       | 765   |
| R <sup>2</sup>          | 0.3630                                    | 0.3624                                    | 0.5295  |
| Adjusted R <sup>2</sup> | 0.2814                                    | 0.2818                                    | 0.4125  |
| F Statistic             | 30.71 <sup>***</sup><br>(df = 11; 593)    | 37.57 <sup>***</sup><br>(df = 9; 595)     | 83.84 <sup>***</sup><br>(df = 8; 596)                 |

Note:

\* p<0.1; \*\* p<0.05; \*\*\* p<0.01

Method: Panel Data Regression with Fixed Effects Estimation

Table 7.2 (i):Panel data regression output for hypothesis 3.

Model (2) shows a positive and strongly significant parameter estimate for the Delta NSFR variable. This shows that an increase in the NSFR is on average associated with a significant increase in a bank's stock of total deposits. In a strict NSFR perspective this makes sense due to the high ASF factors that are assigned to each of the six different deposit categories. For this reason, we would expect to see a positive and significant sign. Of course, many other objectives might drive

the yearly changes in a bank's stock of total deposits. An example of this is the positive and significant parameter estimate of the Total Assets variable in model (2). When banks are increasing in size as measured by their amount of total assets, this is on average associated with a significant increase in the stock of total deposits. This indicates that banks' balance sheet expansions are partly funded by increases in total deposits.

Model (3) regresses the ratio of total deposits to total liabilities onto the 11 explanatory variables. The first observation that can be made is the insignificant parameter estimate of the Delta NSFR variable. According to this, the ratio of total deposits to total liabilities does not prove to be a significant driver of the yearly changes in the NSFR. Thereby we cannot verify hypothesis 3 or the suspicion that an increase in the ratio of total deposits to total liabilities should be associated with an increase in the NSFR.

To test hypothesis 4 we conduct a regression for the ratio of each of the six different deposit categories to total liabilities. The regression results are shown in table 7.2 (ii) on the following page.

|                         | <i>Dependent variable:</i>     |                                      |                                      |                                    |                                |                                  |
|-------------------------|--------------------------------|--------------------------------------|--------------------------------------|------------------------------------|--------------------------------|----------------------------------|
|                         | Delta Ratio of<br>LT Time Dep. | Delta Ratio of ST<br>Large Time Dep. | Delta Ratio of ST<br>Small Time Dep. | Delta Ratio of<br>Transaction Dep. | Delta Ratio of<br>Foreign Dep. | Delta Ratio of<br>Wholesale Dep. |
|                         | (1)                            | (2)                                  | (3)                                  | (4)                                | (5)                            | (6)                              |
| Delta NSFR              | 0.0514***<br>(0.0107)          | -0.1409***<br>(0.0190)               | -0.0163**<br>(0.0079)                | 0.0205***<br>(0.0054)              | -0.0001<br>(0.0001)            | 0.0848***<br>(0.0158)            |
| Lagged NSFR<br>Deficit  |                                | 0.0431**<br>(0.0191)                 |                                      |                                    |                                |                                  |
| Delta LCR               |                                | 0.0276***<br>(0.0057)                | 0.0086***<br>(0.0023)                |                                    |                                | -0.0287***<br>(0.0046)           |
| Lagged LCR<br>Deficit   |                                | -0.0273***<br>(0.0054)               |                                      |                                    |                                |                                  |
| Delta LR                |                                | -0.2167**<br>(0.1007)                | -0.1651***<br>(0.0552)               |                                    |                                | 0.5355***<br>(0.1111)            |
| Lagged LR<br>Deficit    |                                | 0.2196**<br>(0.1037)                 | 0.1299**<br>(0.0570)                 |                                    |                                | -0.4530***<br>(0.1143)           |
| Total Assets            |                                | 0.0000**<br>(0.0000)                 |                                      |                                    |                                |                                  |
| 2011 Dummy              | -0.0081***<br>(0.0027)         | 0.0766***<br>(0.0028)                |                                      |                                    |                                |                                  |
| 2012 Dummy              | -0.0138***<br>(0.0025)         |                                      | 0.0032**<br>(0.0016)                 |                                    |                                |                                  |
| 2013 Dummy              | -0.0113***<br>(0.0026)         |                                      | 0.0061***<br>(0.0016)                |                                    |                                | -0.0152***<br>(0.0031)           |
| 2014 Dummy              | -0.0073***<br>(0.0026)         |                                      | 0.0059***<br>(0.0016)                |                                    |                                | -0.0219***<br>(0.0031)           |
| Observations            | 805                            | 765                                  | 765                                  | 805                                | 805                            | 765                              |
| R <sup>2</sup>          | 0.0978                         | 0.6671                               | 0.0852                               | 0.0221                             | 0.0012                         | 0.2147                           |
| Adjusted R <sup>2</sup> | 0.0777                         | 0.5197                               | 0.0665                               | 0.0176                             | 0.0009                         | 0.1678                           |
| F Statistic             | 13.8603***<br>(df = 5; 639)    | 149.2988***<br>(df = 8; 596)         | 7.9433***<br>(df = 7; 597)           | 14.5231***<br>(df = 1; 643)        | 0.7519<br>(df = 1; 643)        | 27.2470***<br>(df = 6; 598)      |

*Note:*

\*p<0.1; \*\*p<0.05; \*\*\*p<0.01

Method: Panel Data Regression with Fixed Effects Estimation

Table 7.2 (ii): Panel data regression output for hypothesis 4.

Each of these different deposit types receives a specific ASF factor according to the NSFR calculation methodology. Specifically the ASF factors that are assigned for each category are: Long-term time deposits (100%), short-term large time deposits (50%), short-term small time deposits (90%), transaction deposits (50%), foreign deposits (50%) and wholesale deposits



(50%).<sup>148</sup> If banks were to use the ratios of these different deposit types to total liabilities for NSFR compliance, it would be expected that they would increase those categories that receive high ASF factors and decrease those that receive low ASF factors. The purpose of this should then be to increase the ASF numerator of the overall NSFR measure. In this way, the ratio of long-term time deposits and short-term small time deposits would be expected to increase as compared to the ratios of other deposit types. This behaviour would be consistent with NSFR accommodation. Of course, a large range of different scenarios could indicate NSFR relevant adjustments. If all deposit types were to increase as a result of an increase in the NSFR, the behaviour could still be NSFR relevant if the deposit categories that receive the highest ASF factors were to increase the most.

From table 7.2 (ii) it can be seen that all of the deposit categories have a significant parameter estimate for the Delta NSFR variable except for the ratio of foreign deposits to total liabilities. This shows that the yearly changes in a bank's NSFR is on average associated with significant changes in the ratios of the different deposit categories. The finding, that five of the six different deposit categories show significant yearly changes, verifies hypothesis 4. This means that the ratios of these five different deposit types are significant linear drivers of the yearly changes in a bank's NSFR.

Another interesting observation from table 7.2 (ii) is that banks are increasing the ratios of long-term time deposits, transaction deposits and wholesale deposits when their NSFRs are increasing. Of course, caution needs be taken when interpreting the underlying reasons for these adjustments. The reasons for the adjustments might be due to a large range of objectives that banks are pursuing. However, the positive and significant parameter estimate of the Delta NSFR variable for the long-term time deposits matches an NSFR relevant adjustment pattern due to the high ASF factor that is assigned to this deposit category. This rationale cannot be applied to transaction deposits and wholesale deposits since these are assigned the lowest possible ASF factors among the six deposit categories. Furthermore, the negative and significant sign of the Delta NSFR variable for short-term large time deposits indicates that banks are decreasing their ratios of this deposit category when their NSFRs are increasing. This makes sense due to the fact that short-term large time deposits receive the lowest possible ASF factor of 50% among the different deposit types. Overall the picture seems to be quite mixed in terms of NSFR relevant adjustment patterns. There is no consistent upwards adjustments of the ratios of the deposit categories with the highest ASF factors. Similarly there is no consistent downwards adjustment of the ratios of the deposit categories that receive low ASF factors. In this way, it seems doubtful that banks' adjustment of the different

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<sup>148</sup> The ASF factor weighting scheme can be found in section 5.2 in table 5.2 (i).

deposit ratios serves as a tool for NSFR compliance. Most likely, the adjustments of these ratios serve a large range of other objectives as well. However, we have found that five of the six different deposit categories are significant drivers of the yearly changes in the NSFR. In addition, we have found that long-term time deposits and short-term large time deposits show an adjustment pattern that could be NSFR relevant. In this sense, it might be the case that the ratios of long-term time deposits and short-term large time deposits are used for NSFR compliance, while some of the other deposit types serve other purposes. However, these are only suspicions and cannot be verified from the regression results.

Turning towards the time dummies across the six deposit categories, structural shifts can be observed for all models except foreign and transaction deposits. Positive structural shifts from 2012 throughout 2014 can be observed in model (3). This means that the average bank have had a more positive change in the ratio of short-term small time deposits to total liabilities from 2012 and onwards. The opposite trend can be observed for model (6), where negative time dummy variable estimates are seen for both 2013 and 2014.

### 7.3 Test of the Derivative Hypothesis

#### Hypothesis 5

*"Banks' adjustment of the ratio of total derivatives to total assets is a significant driver of the yearly changes in the NSFR"*

#### Hypothesis Regression Setup

To test hypothesis 5 we construct a response variable that expresses the yearly changes in a given bank's ratio of total derivatives to total assets.

$$\Delta \text{Ratio of Total Derivatives to Total Assets}_{i,t} = \Delta \frac{\text{Total Derivatives}_{i,t}}{\text{Total Assets}_{i,t}}$$

$$\Delta \text{Ratio of Total Derivatives to Total Assets}_{i,t} = \frac{\text{Total Derivatives}_{i,t}}{\text{Total Assets}_{i,t}} - \frac{\text{Total Derivatives}_{i,t-1}}{\text{Total Assets}_{i,t-1}}$$

In the interest of additional insight, we also construct a variable that expresses the yearly changes in the stock of total derivatives.

$$\Delta \text{Total Derivatives}_{i,t} = \text{Total Derivatives}_{i,t} - \text{Total Derivatives}_{i,t-1}$$

The regression model that we examine in order to test hypothesis 5 takes the following form.

$\Delta \text{Ratio of Total Derivatives to Total Assets}_{i,t}$

$$\begin{aligned} &= \beta_1 \Delta \text{NSFR}_{i,t} + \beta_2 \text{Lagged NSFR Deficit}_{i,t} + \beta_3 \Delta \text{LCR}_{i,t} + \beta_4 \text{Lagged LCR Deficit}_{i,t} \\ &+ \beta_5 \Delta \text{LR}_{i,t} + \beta_6 \text{Lagged LR Deficit}_{i,t} + \beta_7 \text{Total Assets}_{i,t} + \beta_8 \text{Dummy2011}_{i,t} \\ &+ \beta_9 \text{Dummy2012}_{i,t} + \beta_{10} \text{Dummy2013}_{i,t} + \beta_{11} \text{Dummy2014}_{i,t} + u_{i,t} \end{aligned}$$

In the following output table, model (1) and (2) will be a full and a reduced regression model for the response variable  $\Delta \text{Total Derivatives}_{i,t}$ . Model (3) denotes a reduced regression model for the response variable  $\Delta \text{Ratio of Total Derivatives To Total Assets}_{i,t}$ . The regression output for hypothesis 5 is shown in table 7.3 on the following page.

|                         | <i>Dependent variable:</i>   |                             |   |
|-------------------------|------------------------------|-----------------------------|---|
|                         | Delta of Total Derivatives   |                             | Delta Ratio of Total Derivatives<br>To Total Assets |
|                         | (1)                          | (2)                         | (3)   |
| Delta NSFR              | -129,744.4<br>(254,397.2)    |                             | -0.0703***<br>(0.0257)                              |
| Lagged NSFR Deficit     | -567,706.7**<br>(256,428.5)  |                             |   |
| Delta LCR               | -38,391.35<br>(81,268.58)    |                             |   |
| Lagged LCR Deficit      | 58,022.45<br>(85,290.96)     |                             |   |
| Delta LR                | -998,704.6<br>(1,361,104)    |                             |   |
| Lagged LR Deficit       | 1,312,158<br>(1,410,733)     |                             |   |
| Total Assets            | 0.0121<br>(0.0130)           |                             |   |
| 2011 Dummy              | -223,397.7***<br>(49,851.47) | -279,479.1***<br>(57,314.3) | -0.0541***<br>(0.0070)                              |
| 2012 Dummy              | -132,268.3**<br>(52,319.4)   | -206,130.7***<br>(57,314.3) | -0.0424***<br>(0.0068)                              |
| 2013 Dummy              | -292,589.3***<br>(58,951.19) | -339,111.4***<br>(57,314.3) | -0.0696***<br>(0.0069)                              |
| 2014 Dummy              | -174,456.5***<br>(65,505.15) | -219,907.9***<br>(57,314.3) | -0.0519***<br>(0.0069)                              |
| Constant                |                              |                             | 0.0547***<br>(0.0049)                               |
| Observations            | 765                          | 805                         | 805   |
| R <sup>2</sup>          | 0.0746                       | 0.0588                      | 0.1222  |
| Adjusted R <sup>2</sup> | 0.0578                       | 0.0468                      | 0.1213  |
| F Statistic             | 4.3457***<br>(df = 11; 593)  | 10.0009***<br>(df = 4; 640) | 22.2502***<br>(df = 5; 799)                         |

*Note:*

\* p<0.1; \*\* p<0.05; \*\*\* p<0.01

Method: Panel Data Regression with Fixed Effects Estimation

Table 7.3. Panel data regression output for hypothesis 5.

An interesting insight from the output table is that the Delta NSFR variable has a significant parameter estimate in model (3), but not in model (2). This shows that a yearly change in the NSFR is on average associated with a significant yearly change in the ratio of total derivatives to total assets, whereas there is no significant change in the level of total derivatives. As discussed in

section 3.2 on hypothesis rationales, derivatives are severely penalized in terms of RSF factor allocation. This means that increases in the ratio or the level of total derivatives will increase the RSF denominator of the NSFR and thereby decrease the overall measure. This pattern is indicated by the significant and negative parameter estimate of the Delta NSFR parameter in model (3). The insignificant parameter estimate of the Delta NSFR variable in model (2) can be partly explained by the asset expansion in the analyzed time period.<sup>149</sup> If the stock of total derivatives is kept constant, an asset expansion will cause a decrease in the ratio of derivatives to total assets. In this way, banks can actually decrease the RSF denominator of the NSFR by carrying out their asset expansions by not increasing their stock of derivatives too extensively. According to this, it seems reasonable that the stock of total derivatives does not fluctuate systematically in relation to a bank's yearly changes in the NSFR.

The significant parameter estimate of the Delta NSFR variable in model (3) verifies hypotheses 5. This shows that the yearly changes in a bank's ratio of total derivatives to total assets is a significant driver of the yearly changes in the NSFR. Furthermore, the negative sign of the parameter estimate aligns with NSFR expected behaviour and indicates that the ratio of total derivatives to total assets could be a used-in-practice tool for NSFR compliance. These findings also corresponds with the suspicions of Danske Bank and PricewaterhouseCoopers as outlined in the section 3.2 on hypothesis rationales. The above insights suggest that NSFR compliance might be one of objectives for a bank's adjustment of the ratio of total derivatives to total assets.

Banks might also be motivated to adjust their ratio of total derivatives to total assets in order to improve some of the other liquidity requirements. In terms of the LR, derivatives will appear in the total assets denominator as a part of the total exposure measure. Hence, a decrease in derivatives will also improve the LR measure. This functional relationship makes it less likely that a bank's stock or ratio of total derivatives is being adjusted with the sole purpose of NSFR compliance. In model (1), it can be seen that the LR variable has a negative, but insignificant parameter estimate. In this case, at least the sign corresponds to LR relevant behaviour, but no conclusion can be drawn due to insignificance.

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<sup>149</sup> As can be seen in section 5.4 on Descriptive Statistics for the Net Stable Funding Ratio, the banks in our sample have experienced a consistent balance sheet expansion throughout 2009 to 2014. The balance sheet expansion is measured as yearly increases in total assets.

## 7.4 Test of the HQLA Hypothesis

### Hypothesis 6

*"Banks' adjustment of the ratio of high-quality liquid assets to total assets is a significant driver of the yearly changes in the NSFR"*

#### Hypothesis Regression Setup

To test hypothesis 6, we construct a response variable that measures the yearly changes in the ratio of total HQLA to total assets.

$$\Delta \text{ Ratio Of Total HQLA To Total Assets}_{i,t} = \Delta \frac{\text{Total HQLA}_{i,t}}{\text{Total Assets}_{i,t}}$$
$$\Delta \text{ Ratio Of Total HQLA To Total Assets}_{i,t} = \frac{\text{Total HQLA}_{i,t}}{\text{Total Assets}_{i,t}} - \frac{\text{Total HQLA}_{i,t-1}}{\text{Total Assets}_{i,t-1}}$$

In the interest of additional insight, we construct a response variable measuring the yearly changes in the stock of total HQLA on a bank's balance sheet.

$$\Delta \text{ Total HQLA}_{i,t} = \text{Total HQLA}_{i,t} - \text{Total HQLA}_{i,t-1}$$

Furthermore, the response variable for the ratio of total HQLA to total assets will be disaggregated into its two main components: HQLA Cash and HQLA Securities. This is done in order to test whether the yearly changes in the NSFR is caused by the yearly changes of one these in particular.

$$\Delta \text{ Ratio Of Total HQLA Cash}_{i,t} \text{ to Total Assets} = \Delta \frac{\text{Total HQLA Cash}_{i,t}}{\text{Total Assets}_{i,t}}$$
$$\Delta \text{ Ratio Of Total HQLA Securities To Total Assets}_{i,t} = \Delta \frac{\text{Total HQLA Securities}_{i,t}}{\text{Total Assets}_{i,t}}$$

The exact regression model that will be examined for hypothesis 6 takes the following form.

$$\begin{aligned} \Delta \text{Ratio of Total HQLA to Total Assets}_{i,t} &= \beta_1 \Delta \text{NSFR}_{i,t} + \beta_2 \text{Lagged NSFR Deficit}_{i,t} + \beta_3 \Delta \text{LCR}_{i,t} + \beta_4 \text{Lagged LCR Deficit}_{i,t} \\ &+ \beta_5 \Delta \text{LR}_{i,t} + \beta_6 \text{Lagged LR Deficit}_{i,t} + \beta_7 \text{Total Assets}_{i,t} + \beta_8 \text{Dummy2011}_{i,t} \\ &+ \beta_9 \text{Dummy2012}_{i,t} + \beta_{10} \text{Dummy2013}_{i,t} + \beta_{11} \text{Dummy2014}_{i,t} + u_{i,t} \end{aligned}$$

In the following output table, model (1) and (2) will be a full and a reduced regression model for the response variable  $\Delta \text{ Total HQLA}_{i,t}$ . Model (3) will denote a reduced regression model for the response variable  $\Delta \text{ Ratio of Total HQLA to Total Assets}_{i,t}$ . Finally model (4) and (5) will denote the regression models for  $\Delta \text{ Ratio of Total HQLA Cash}_{i,t} \text{ to Total Asset}$  and

$\Delta$  Ratio of Total HQLA Securities to Total Assets<sub>i,t</sub> respectively. The regression results are shown below in table 7.4.

|                         | <i>Dependent variable:</i>                |   |  |   |   |
|-------------------------|---|---|--|---|---|
|                         | Delta of Total HQLA                       |   | Delta Ratio of Total HQLA                | Delta Ratio of HQLA Cash                | Delta Ratio of HQLA Securities          |
|                         | (1)                                       | (2)                                       | (3)                                      | (4)                                     | (5)                                     |
| Delta NSFR              | 2,790,284 <sup>***</sup><br>(362,721)     | 2,537,170 <sup>***</sup><br>(255,488.8)   | 0.3524 <sup>***</sup><br>(0.0159)        | 0.1936 <sup>***</sup><br>(0.0203)       | 0.1677 <sup>***</sup><br>(0.0212)       |
| Lagged NSFR Deficit     | -392,751.6<br>(365,617.4)                 |   |  | 0.0438 <sup>**</sup><br>(0.0206)        | -0.0454 <sup>**</sup><br>(0.0220)       |
| Delta LCR               | -27,370.66<br>(115,873.3)                 |   | 0.0275 <sup>***</sup><br>(0.0056)        | 0.0154 <sup>***</sup><br>(0.0047)       |   |
| Lagged LCR Deficit      | 114,451.2<br>(121,608.4)                  |   | -0.0134 <sup>**</sup><br>(0.0052)        |   |   |
| Delta LR                | -10,826,543 <sup>***</sup><br>(1,940,671) | -10,569,224 <sup>***</sup><br>(1,854,313) |  | -0.0676 <sup>**</sup><br>(0.0294)       |   |
| Lagged LR Deficit       | 10,142,612 <sup>***</sup><br>(2,011,432)  | 9,705,370 <sup>***</sup><br>(1,889,615)   |  |   |   |
| Total Assets            | 0.0448 <sup>**</sup><br>(0.0185)          | 0.0457 <sup>***</sup><br>(0.0161)         |  |   |   |
| 2011 Dummy              | 183,486 <sup>**</sup><br>(71,078.54)      | 160,719.7 <sup>***</sup><br>(52,411.43)   | 0.0219 <sup>***</sup><br>(0.0032)        | 0.0157 <sup>***</sup><br>(0.0031)       |   |
| 2012 Dummy              | 115,325.6<br>(74,597.34)                  | 109,030.5 <sup>**</sup><br>(50,121.47)    |  | 0.0066 <sup>**</sup><br>(0.0031)        | -0.0176 <sup>***</sup><br>(0.0036)      |
| 2013 Dummy              | 13,170.24<br>(84,052.99)                  |   |  |   | -0.0085 <sup>**</sup><br>(0.0036)       |
| 2014 Dummy              | -1,620.325<br>(93,397.67)                 |   | -0.0077 <sup>**</sup><br>(0.0033)        |   | -0.0223 <sup>***</sup><br>(0.0037)      |
| Observations            | 765                                       | 765                                       | 805                                      | 765                                     | 805                                     |
| R <sup>2</sup>          | 0.2406                                    | 0.2375                                    | 0.5355                                   | 0.3038                                  | 0.1754                                  |
| Adjusted R <sup>2</sup> | 0.1865                                    | 0.1857                                    | 0.4251                                   | 0.2375                                  | 0.1393                                  |
| F Statistic             | 17.0828 <sup>***</sup><br>(df = 11; 593)  | 31.0467 <sup>***</sup><br>(df = 6; 598)   | 147.3515 <sup>***</sup><br>(df = 5; 639) | 43.4866 <sup>***</sup><br>(df = 6; 598) | 27.1909 <sup>***</sup><br>(df = 5; 639) |

Note:

\* p<0.1; \*\* p<0.05; \*\*\* p<0.01

Method: Panel Data Regression with Time Specific Effects and Fixed Effects Estimation  
Table 7.4 Panel data regression output for hypothesis 6.

From model (2) it can be seen that an increase in the NSFR is associated with a significant increase in the stock of total HQLA. This is revealed by the positive and significant parameter estimate of

the Delta NSFR variable. As mentioned earlier, HQLA comprises cash and those securities that are assigned risk-weights of 0% or 20% under the Basel II Standardized Approach for credit risk. From model (3) it can be seen that there is a positive and significant linear relationship between the yearly changes in the NSFR and the yearly changes in the ratio of total HQLA to total assets. This reveals that changes in the ratio of total HQLA to total assets is a significant driver of the changes in the NSFR and this finding verifies hypothesis 6.

Furthermore, the sign of the parameter estimate of the Delta NSFR variable in model (3) aligns with NSFR relevant behaviour. A bank's stock of total HQLA is treated very favourably by the NSFR calculation methodology in terms of RSF factors as compared to other asset types. This means that an increase in the ratio of total HQLA to total assets should lead to a decrease in the RSF denominator and thereby increase the overall NSFR measure. Specifically, the balance sheet items that are contained in the HQLA definition receive low RSF factors as compared to other asset types. This makes the HQLA items an attractive asset category in an NSFR compliance perspective. As with the other hypotheses, we cannot state direct causality due to the multiple objectives pursued by banks. The ratio of total HQLA to total assets could be changed for a large range of reasons. However, as we have controlled for a set of relevant effects, it is possible to suggest that the ratio of total HQLA to total assets is a used-in-practice tool for NSFR compliance.

From model (3) we can also observe a positive and significant sign for the Delta LCR variable. This means that in periods where banks have seen increases in their LCRs, these have on average been associated with increases in the ratio of total HQLA to total assets. In a theoretical perspective, this makes sense due to the construction of the LCR. The numerator of the LCR is comprised by a bank's stock of total HQLA. According to this, banks can improve their LCRs by increasing their ratio of total HQLA to total assets. This indicates that the ratio of total HQLA to total assets might also serve the purpose of LCR compliance.

An additional insight from model (3) can be found by interpreting the negative and significant parameter estimate of the Lagged LCR Deficit variable. The negative sign reveals that when banks have seen a decrease in their gap towards the LCR target of 100%, this has been associated with a significant increase in the ratio of total HQLA to total assets. This finding aligns perfectly with the



above finding as increases in the ratio of total HQLA will increase the overall LCR measure and thereby decrease the gap towards the LCR target.

Turning towards model (4) and (5) we can observe positive and significant parameter estimates for the Delta NSFR variable in both models. This means that there exists a significant linear relationship between the yearly changes in banks' NSFRs and the yearly changes in their ratios of HQLA cash and HQLA securities to total assets. When examining the Delta LCR variable, it is observed that significance is found only for model (4). This means that the yearly changes in the ratio of HQLA cash is a significant driver of the yearly changes in a bank's LCR. This finding might come across as being somewhat surprising, since the numerator of the LCR measure is comprised by both HQLA cash and HQLA securities. A possible explanation can be found by looking at the calculation of the numerator of the LCR. In this calculation a unit of HQLA cash receives a weight that is 15 percentage points higher as compared to HQLA securities (100% vs. 85%). In this way, it seems reasonable that banks are focusing relatively more on the ratio of HQLA cash to total assets since this component of the LCR numerator will have the largest overall impact on the total measure.

As a last insight from the HQLA regressions, it can be seen that the yearly changes in the LR of banks are on average associated with a significant decrease in the ratio of HQLA cash to total assets. This is revealed by the negative and significant sign of the Delta LR parameter estimate in model (4). This negative sign is expected due to the fact that HQLA cash will appear as a part of the denominator of the LR. Thereby, increases in a bank's ratio of HQLA cash to total will increase the total assets part of the total exposure measure in the LR and decrease the overall ratio.

The above findings indicate that banks are using the ratio of total HQLA to total assets for multiple compliance purposes. We can observe that the ratio of total HQLA to total assets is a significant driver of the yearly changes in the NSFR and the LCR. Furthermore, we can see that the cash component of the total stock of HQLA seems to be the most widely used tool for potential compliance with the liquidity requirements. Of course, we cannot state causality. However, since the regression results matches a pattern that could indeed be NSFR and LCR relevant it seems possible that banks are using their ratio of total HQLA to total assets as a tool for NSFR compliance, as well as LCR compliance.

## 7.5 Test of the Lending Hypotheses

### Hypothesis 7

*"Banks' adjustment of the ratio of total lending to total assets is a significant driver of the yearly changes in the NSFR"*

### Hypothesis 8

*"Banks' adjustment of their ratios of different risk-segmented loan types to total assets is a significant driver of the yearly changes in the NSFR"*

### Hypothesis Regression Setup

To test hypothesis 7 we construct a response variable that expresses the yearly changes in the ratio of total lending to total assets for the aggregated amount of all loans on the asset side of a bank's balance sheet.

$$\Delta \text{Ratio of Total Lending to Total Assets}_{i,t} = \Delta \frac{\text{Total Lending}_{i,t}}{\text{Total Assets}_{i,t}}$$
$$\Delta \text{Ratio of Total Lending to Total Assets}_{i,t} = \frac{\text{Total Lending}_{i,t}}{\text{Total Assets}_{i,t}} - \frac{\text{Total Lending}_{i,t-1}}{\text{Total Assets}_{i,t-1}}$$

To test hypothesis 8 we construct a response variable that expresses the yearly changes in the ratio of each loan type across risk-weights. We construct one variable for each of the four risk-weight categories as outlined in the NSFR framework: 0%, 20%, 50% and 100%.

$$\Delta \text{Ratio of Lending Type } j_{i,t} = \Delta \frac{\text{Amount of Lending Type } j_{i,t}}{\text{Total Lending}_{i,t}} \text{ for } j = 1, \dots, 4$$

In the interest of additional insight, we also construct a response variable for the yearly change in the overall amount of lending for a given bank.

$$\Delta \text{Total Lending}_{i,t} = \text{Total Lending}_{i,t} - \text{Total Lending}_{i,t-1}$$

The exact regression model that will be examined for hypothesis 7 takes the following form.

$$\begin{aligned} \Delta \text{Ratio of Total Lending to Total Assets}_{i,t} &= \beta_1 \Delta \text{NSFR}_{i,t} + \beta_2 \text{Lagged NSFR Deficit}_{i,t} + \beta_3 \Delta \text{LCR}_{i,t} + \beta_4 \text{Lagged LCR Deficit}_{i,t} \\ &+ \beta_5 \Delta \text{LR}_{i,t} + \beta_6 \text{Lagged LR Deficit}_{i,t} + \beta_7 \text{Total Assets}_{i,t} + \beta_8 \text{Dummy2011}_{i,t} \\ &+ \beta_9 \text{Dummy2012}_{i,t} + \beta_{10} \text{Dummy2013}_{i,t} + \beta_{11} \text{Dummy2014}_{i,t} + u_{i,t} \end{aligned}$$

The model that we set up for hypothesis 8 will be identical in terms of the right-hand side, however, we will conduct a separate regression for each of the four loan types.

In the following output table, model (1) and (2) will be a full and a reduced regression model for the response variable  $\Delta$  Total Lending<sub>i,t</sub>. Model (3) will denote a reduced regression model for the response variable  $\Delta$  Ratio of Total Lending to Total Assets<sub>i,t</sub>. Finally, model (4) to (7) will display the models for  $\Delta$  Ratio of Lending Type  $j_{i,t}$  representing each of the four different risk-weight loan categories. The regression results are shown below in table 7.5.

|                         | <i>Dependent variable:</i>    |                               |                              |                           |                            |                            |                             |
|-------------------------|-------------------------------|-------------------------------|------------------------------|---------------------------|----------------------------|----------------------------|-----------------------------|
|                         | Delta of Total Loans          |                               | Delta Ratio of Total Loans   | Delta Ratio of Loans 0RW  | Delta Ratio of Loans 20RW  | Delta Ratio of Loans 50RW  | Delta Ratio of Loans 100RW  |
|                         | (1)                           | (2)                           | (3)                          | (4)                       | (5)                        | (6)                        | (7)                         |
| Delta NSFR              | -1,253,216***<br>(312,314.5)  | -852,409.5***<br>(224,113.7)  | -0.2905***<br>(0.0160)       | -0.0023<br>(0.0015)       | -0.0064<br>(0.0095)        | -0.0268***<br>(0.0101)     | -0.2620***<br>(0.0219)      |
| Lagged NSFR Deficit     | 389,591<br>(314,808.2)        |                               |                              |                           |                            |                            | 0.0430*<br>(0.0219)         |
| Delta LCR               | -287,266.4***<br>(99,770.56)  | -319,481.9***<br>(89,625.74)  | -0.0126***<br>(0.0043)       |                           |                            |                            | -0.0153***<br>(0.0050)      |
| Lagged LCR Deficit      | 237,999.8**<br>(104,708.7)    | 285,807.4***<br>(79,739.52)   |                              |                           |                            |                            |                             |
| Delta LR                | -19,409,741***<br>(1,670,979) | -19,203,469***<br>(1,641,884) |                              |                           | -0.1489**<br>(0.0692)      |                            | 0.5091***<br>(0.1206)       |
| Lagged LR Deficit       | 18,541,246***<br>(1,731,906)  | 18,434,614***<br>(1,694,676)  |                              |                           | 0.1516**<br>(0.0717)       |                            | -0.4972***<br>(0.1244)      |
| Total Assets            | 0.2150***<br>(0.0159)         | 0.2176***<br>(0.0139)         |                              |                           | -0.0000**<br>(0.0000)      |                            |                             |
| 2011 Dummy              | -74,018.67<br>(61,200.88)     |                               | -0.0131***<br>(0.0039)       | 0.0005*<br>(0.0003)       | -0.0055**<br>(0.0025)      |                            |                             |
| 2012 Dummy              | 41,308.37<br>(64,230.68)      |                               | 0.0173***<br>(0.0037)        |                           | -0.0076***<br>(0.0025)     | 0.0062***<br>(0.0020)      | 0.0217***<br>(0.0036)       |
| 2013 Dummy              | -16,245.5<br>(72,372.3)       |                               | 0.0230***<br>(0.0038)        |                           | -0.0066**<br>(0.0027)      |                            | 0.0308***<br>(0.0036)       |
| 2014 Dummy              | -32,623.82<br>(80,418.36)     |                               | 0.0241***<br>(0.0038)        |                           | -0.0057**<br>(0.0028)      |                            | 0.0338***<br>(0.0036)       |
| Observations            | 765                           | 765                           | 805                          | 805                       | 765                        | 805                        | 765                         |
| R <sup>2</sup>          | 0.4854                        | 0.4801                        | 0.4904                       | 0.0112                    | 0.0466                     | 0.0213                     | 0.4443                      |
| Adjusted R <sup>2</sup> | 0.3762                        | 0.3753                        | 0.3887                       | 0.0089                    | 0.0363                     | 0.0170                     | 0.3461                      |
| F Statistic             | 50.8429***<br>(df = 11; 593)  | 92.0505***<br>(df = 6; 598)   | 102.3252***<br>(df = 6; 638) | 3.6201**<br>(df = 2; 642) | 3.6400***<br>(df = 8; 596) | 6.9724***<br>(df = 2; 642) | 59.5546***<br>(df = 8; 596) |

Note:

\* p<0.1; \*\* p<0.05; \*\*\* p<0.01

Method: Panel Data Regression with Time Specific Effects and Fixed Effects Estimation  
Table 7.5: Panel data regression output for hypotheses 7 and 8.

As a first observation, we can see a negative and significant parameter estimate of the Delta NSFR variable in model (2). This shows that there exists a significant linear relationship between the yearly changes in the NSFR and the yearly changes in the total amount of lending. This means that banks on average have been decreasing their total amount of lending in periods where the NSFR has been increasing. This empirical relationship aligns with the expectation if the adjustments of the amount of lending were to be NSFR relevant. According to the NSFR calculation methodology the lending business of banks is subject to a rather severe RSF penalization. Specifically, loans with risk-weights of 0%, 20%, 50% and 100% receive RSF factors of 50%, 65%, 85% and 100% respectively. This allocation scheme provides the intuition behind the negative sign of the Delta NSFR parameter estimate in model (2). An additional insight from model (2) is the possibility that the total amount of lending for banks serves the purpose of compliance with multiple liquidity requirements. This is indicated by the negative and significant parameter estimates of the Delta LCR and Delta LR variable. This shows that when banks are increasing their LCR or their LR, this is on average associated with a significant decrease in the total amount of lending on their balance sheets.

In order to test hypothesis 7 we will have to evaluate model (3). In this model we find a negative and significant parameter estimate of the Delta NSFR variable. This means that the yearly changes in a bank's ratio of total lending to total assets has on average been associated with significant changes in the NSFR. In periods where the NSFR has increased this has been associated with a decrease in the ratio of total lending to total assets. This finding verifies hypothesis 7, and it can thereby be stated that the ratio of total lending to total assets is a significant driver of the yearly changes in the NSFR. Of course, causality cannot be stated, especially as the ratio of total lending to total assets might serve a large range of other purposes than regulatory compliance. However, the empirical pattern that can be read from model (3) indicates that the ratio of total lending to total assets could serve as a used-in-practice tool for NSFR compliance.

To test hypothesis 8, we can evaluate the sign and significance of the parameter estimates of the Delta NSFR variable for models (4) to (7). In order for hypothesis 8 to be true, it would be expected to observe significant and negative signs for the Delta NSFR parameter estimates for loans with high risk-weights and/or positive and significant signs in the models for loan types with low risk-weights. This theoretical behaviour would lead to an increasing ratio of loans that are assigned low

RSF factors and a decreasing ratio of loans that are assigned high RSF factors. This would result in a lower RSF denominator of the NSFR and thereby increase the overall measure. Another option would be an empirical pattern where banks are actually increasing or decreasing all of the four different loan types. This should then be done in such a way that the loan types that are assigned high risk-weights are decreased more than the other types if a general lending ratio decrease is present. Conversely, if a general lending ratio increase is present, the high-risk loans would be expected to show smaller increases as compared to the low-risk loan types.

In models (4) to (7) we see that an increase in the NSFR is associated with a general decline in all of the ratios of different loan types to total assets. This can be seen by the negative parameter estimates of the Delta NSFR variable for each of the four models. However, it is only for the 50% and 100% risk-weighted securities that we observe a significant estimate. We also see that the magnitude of the parameter estimate is largest for the loan types that are assigned a 100% risk-weight. This empirical pattern matches the general lending ratio decrease scenario as outlined above. Based on these results it is possible to verify hypothesis 8, that banks' adjustment of different loan types is a significant driver of the yearly changes in the NSFR. Again, the adjustments of the different loan types might serve other purposes than regulatory compliance. However, the adjustment pattern indicates that banks are accommodating for the NSFR requirement by decreasing their ratio of high-risk loans at a faster pace than the ratios of lower risk loan types.

## 7.6 Summary of the Hypotheses Testing

This section provides a summary of the main findings from the testing of our eight hypotheses. It presents the findings in a tabular overview and presents the most interesting observations and insights for each of the hypotheses.

| Hypothesis | Response Variable  | t-test of Parameter Estimate <sup>150</sup> | Sign <sup>151</sup> | Match Between Empirical Findings and a potentially NSFR Relevant Pattern <sup>152</sup>  |
|------------|--|---|---------------------|--|
| 1          | Delta Ratio of Total Securities to Total Assets                                  | Significant                                 | +                   | No Match - Balance Sheet Item Unlikely to Serve the Purpose of NSFR Compliance   |
| 2          | Delta Ratio of Security Type j to Total Assets across Risk-Weights               | 0 % Risk-Weight: Insignificant              | NA                  | Match - Potential Used-In-Practice Item for NSFR Compliance  |
|            |  | 20 % Risk-Weight: Significant               | +                   |  |
|            |  | 50 % Risk-Weight: Significant               | +                   |  |
|            |  | 100 % Risk-Weight: Significant              | -                   |  |
| 3          | Delta Ratio of Total Deposits to Total Liabilities                               | Insignificant                               | NA                  | No conclusion can be drawn due to insignificance   |
| 4          | Delta Ratio of Deposit Category j to Total Liabilities across Deposit Categories | LT Time Dep: Significant                    | +                   | Partial Match - Empirical Pattern Matches an NSFR Relevant Pattern in the Case of Long-Term Time Deposits and Short-Term Small Time Deposits |
|            |  | ST Large Time Dep: Significant              | -                   |  |
|            |  | ST Small Time Dep: Significant              | -                   |  |
|            |  | Transaction Dep: Significant                | +                   |  |
|            |  | Foreign Dep: Insignificant                  | NA                  | Potential Used-In-Practice Item for NSFR Compliance  |
|            |  | Wholesale Dep: Significant                  | +                   |  |
| 5          | Delta Ratio of Total Derivatives to Total Assets                                 | Significant                                 | -                   | Match - Potential Used-In-Practice Item for NSFR Compliance  |
| 6          | Delta Ratio of Total HQLA to Total Assets  | Significant                                 | +                   | Match - Potential Used-In-Practice Item for NSFR   |
| 7          | Delta Ratio of Total Lending to Total Assets                                     | Negative                                    | -                   | Match - Potential Used-In-Practice Item for NSFR Compliance  |
| 8          | Delta Ratio of Lending Category j to Total Assets across Risk-Weights            | 0 % Risk-Weight: Insignificant              | -                   | Match - Potential Used-In-Practice Item for NSFR Compliance. High-Risk Securities are Decreased to a Larger Extent than Low-Risk Securities  |
|            |  | 20 % Risk-Weight: Insignificant             | -                   |  |
|            |  | 50 % Risk-Weight: Significant               | -                   |  |
|            |  | 100 % Risk-Weight: Significant              | -                   |  |

Table 7.6: Overview of the main results from the hypothesis testing section.

<sup>150</sup> The t-test is a regular double-sided significance test on a 5% significance level with null being that the parameter estimate is equal to zero against the alternative that is it different from 0.

<sup>151</sup> This will denote the sign of the parameter estimate of the Delta NSFR variable in the reduced regression model of the given response variable.

<sup>152</sup> The matching procedure is based on a comparison of sign and significance between empirical pattern and the expectation for the regression outcome in the case that the adjustments should serve as a tool for NSFR compliance. It will be a match if the given balance sheet item displays characteristics that could be NSFR relevant.

### *Hypothesis 1 - Changes in the Ratio of Total Securities to Total Assets as a Driver of NSFR*

The yearly changes in a bank's ratio of total securities to total assets proved to be a significant linear driver of the yearly changes in the NSFR. This finding verifies hypothesis 1. However, the positive sign of the parameter estimate of the Delta NSFR variable is opposite to the expectation if the adjustments were to be NSFR relevant. Securities are subject to a somewhat rough RSF treatment. Therefore it would be expected that increases in the ratio of total securities to total assets would increase the RSF denominator of the NSFR and thereby decrease the overall measure. The fact that we observe the opposite indicates that banks are not using reductions in their ratio of total securities to total assets as an NSFR accommodation strategy. Thereby, our suspicion is rejected. As an alternative, it might be the case that the ratio of securities is increased while other asset types that are penalized even harder in terms of RSF factors are decreased. This could explain the positive sign of the Delta NSFR variable.

### *Hypothesis 2 - Changes in the Ratio of Security Type $j$ to Total Assets as a Driver of NSFR*

The yearly changes in the ratios of different security types segmented across risk-weightings turned out to be significant linear drivers of the NSFR. This finding verifies hypothesis 2. The only exception was the 0% risk-weighted securities. The finding of downwards adjustment of 100% risk-weighted securities and upwards adjustment of lower risk securities as a result of an NSFR increase, indicates that banks' adjustments of different security types could potentially serve the purpose of NSFR compliance.

### *Hypothesis 3 - Changes in the Ratio of Total Deposits to Total Liabilities as a Driver of NSFR*

It was found that the ratio of total deposits to total liabilities was not a significant driver of the yearly changes in the NSFR. An insignificant parameter estimate was found for the Delta NSFR variable which rejected the hypothesis. However, the positive sign of the parameter estimate indicated that if banks were to use the ratio of total deposits to total liabilities, it would be done by increasing the ratio and thereby increase the ASF denominator of the NSFR. But, as a conclusion, it cannot be stated that banks are using the ratio of total deposits to total liabilities as a tool for NSFR compliance.

*Hypothesis 4 - Changes in the Ratio of Deposit Type j to Total Liabilities as a Driver of NSFR*

Our suspicion that the yearly changes in the ratio of those deposit types that are assigned high ASF factors would be positively correlated with the yearly changes in the NSFR is not possible to verify. The empirical pattern matches an NSFR relevant pattern in the case of long-term time deposits and short-term large time deposits. However, for the remaining types of deposits the pattern is quite mixed and counterintuitive in terms of NSFR relevance. The ratios of all of the six deposit types, except for foreign deposits, proved to be significant drivers of the yearly changes in the NSFR. This finding verifies hypothesis 4.

*Hypothesis 5 - Changes in the Ratio of Total Derivatives to Total Assets as a Driver of NSFR*

We have found that in periods where the NSFR is increasing this is associated with a significant linear decrease of the ratio of total derivatives to total assets. This finding verifies hypothesis 5. This behaviour aligns with our expectation since derivatives is a heavily penalized item on a bank's balance sheet in terms of NSFR compliance. Thereby, the regression results show an adjustment pattern that matches the expectation of NSFR relevance. Thereby, our findings suggests that downwards adjustments of the ratio of total derivatives to total assets could be a used-in-practice tool for NSFR compliance.

*Hypothesis 6 - Changes in the Ratio of Total HQLA to Total Assets as a Driver of NSFR*

From the regression results it is evident that banks' yearly increases in their NSFRs are associated with increases in the ratio of total HQLA to total assets. The positive and significant parameter estimate of the Delta NSFR variable verifies hypothesis 6 and proves its role as a linear driver of the yearly changes in the NSFR. The positive sign was expected due to the fact that HQLA receives a favourable RSF treatment. This means that a larger ratio of total HQLA to total assets will decrease the denominator of the NSFR and thereby increase the overall measure. This adjustment behaviour follows a pattern that could be NSFR relevant. This indicates that banks are potentially using increases in the ratio of total HQLA to total assets as a tool for NSFR compliance. Furthermore, it proved to be the changes in the ratio of the cash component of total HQLA that provided the majority of the impact onto the changes in the NSFR.



Lastly, it was found that the yearly changes in the ratio of total HQLA to total assets was a significant driver of the yearly changes in the LCR. This aligns with our expectation due to the fact that HQLA makes out the numerator of the LCR.

*Hypothesis 7 - Changes in the Ratio of Total Lending to Total Assets as a Driver of NSFR*

As expected, the Delta NSFR parameter estimate turned out to be significant and negative. This proved that the yearly changes in the ratio of total lending to total assets is a significant driver of the yearly changes in the NSFR. The rationale behind the negative correlation lies within the severe RSF punishment of lending on a bank's balance sheet. Based on risk-weighting, any loan type receives an RSF factor between 50% and 100%. In this way, increases in the ratio of total lending to total assets will increase the RSF denominator and thereby decrease the overall NSFR measure. The match between the expected and the empirical pattern indicates that banks are potentially using reductions in their ratio of lending volumes on their balance sheets as a tool for NSFR compliance.

*Hypothesis 8 - Changes in the Ratio of Lending Type  $j$  to Total Assets as a Driver of NSFR*

It is evident from the regression results that in periods where the NSFR is increased, the ratios of all lending types across risk-weightings are being decreased. This behaviour verifies hypothesis 8. Furthermore, we observe a match between the regression results and an adjustment behaviour that could potentially be NSFR relevant. When an increase in the NSFR is observed, the ratio of loan types that receive the highest RSF factors are decreased to a much larger extent than those loan types that receive lower risk-weightings. This pattern reveals that banks' adjustment of their ratios of different loan types to total assets could potentially serve the purpose of NSFR compliance.

## 8. Conclusion

Our goal has been to investigate how banks can potentially accommodate for the forthcoming Net Stable Funding Ratio requirement in terms of balance sheet adjustments. More specifically, we have investigated what particular balance sheet items that can prove to be significant drivers of the yearly NSFR changes of banks. The investigation has been based on a set of 8 hypotheses on expected adjustment patterns for a selected range of balance sheet items. Through the hypothesis testing we have provided an answer to the following question.

*How can banks amend their balance sheets in order to comply with the NSFR?*

The analysis has been conducted for a sample comprising the 161 largest U.S. commercial banks based on granular Call Report data from the FFIEC<sup>153</sup>. As a first part of the analysis, a set of 8 different hypotheses has been formally tested via panel data regression analysis across a time-window ranging from 2009 to 2014. These regressions have been carried out in order to test the driver capabilities of the balance sheet items contained in the hypotheses. As a second part of the analysis we have set up a matching procedure in order to evaluate whether a certain balance sheet item might serve the partial or sole purpose of NSFR compliance. Through this matching procedure, we have made a comparison between the empirically observed patterns from the regression results and the expected theoretical behaviour if the adjustments of the balance sheet item were to be NSFR motivated.

As an integrated part of the investigation of banks' balance sheet adjustments towards NSFR compliance, this thesis has contributed along three different dimensions. First of all, we have calculated the NSFR for 6750 U.S commercial banks of which the largest 161 of these have been used as a regression sample for hypothesis testing. It is evident from the calculations that the largest U.S commercial banks on average are centred fairly close around the NSFR target of 1 already as of 2009. Furthermore, the distribution of NSFRs across the sample has become more narrow in terms of decreasing standard deviation and skewness from 2009 to 2014. These findings reveal that changes of the NSFRs are taking place, and that banks who are overperforming according to the target are actually cutting slightly back on their NSFR levels.

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<sup>153</sup> The FFIEC (Federal Financial Institutions Examination Council) is a combined institution that prescribes uniform principles, standards and report forms for a large range of financial and governmental bodies including the Board of Governors of the Federal Reserve System (FRB), the Federal Deposit Insurance Corporation (FDIC), the National Credit Union Administration (NCUA), the Office of the Comptroller of the Currency (OCC). <https://cdr.ffiec.gov/public>.

Secondly, we have found that a particular set of balance sheet items have proved to be linear drivers of the yearly changes in the NSFRs of the largest U.S commercial banks. From the matching procedure, we have observed empirical patterns that matches a behaviour that could potentially be strictly NSFR relevant. Based on these patterns, we can provide a set of proposals for balance sheet adjustments towards NSFR compliance.

Third, we have established a foundation for future research by providing material for further analyses and descriptive statistical insights. More specifically, this contribution lies within the construction of a dataset comprising 6570 U.S. commercial banks measured along 334 different variables that have been sampled across six consecutive years via Call Reports provided by the FFIEC.

The finding of significant relationships between certain balance sheet items and the NSFR leads to the following proposals for potential balance sheet adjustments towards NSFR compliance.

*Banks can decrease the Ratio of High-Risk Securities to Total Assets*

The regression results show that banks can improve their NSFRs by decreasing the ratio of securities that receives a 100% risk-weighting. Similarly, banks can improve their NSFRs by increasing the ratios of securities that are assigned risk-weights of 20% and 50%.

*Banks can increase their Ratios of two specific Deposit Types to Total Liabilities*

First, banks can improve their NSFRs by focusing on increasing the ratio of long-term time deposits to total liabilities. This particular deposit type receives the highest possible ASF factor of 100% and will thereby have a large positive impact onto the ASF numerator of the NSFR. Second, banks can improve their NSFRs by reducing the ratio of short-term large time deposits as this deposit type receive the lowest possible ASF factor among the six different deposit types.

*Banks can decrease the Ratio of Total Derivatives to Total Assets*

Derivatives are subject to the most penalizing RSF treatment of all asset types on a bank's balance sheet. By decreasing the ratio of total derivatives to total assets, banks can decrease the RSF denominator of the NSFR and thereby increase the overall measure.

*Banks can increase the Ratio of Total HQLA to Total Assets*

The components of a bank's stock of total HQLA receives low RSF factors. Thereby banks can lower the RSF denominator of the NSFR by increasing their ratio of total HQLA to total assets and in this way improve their NSFRs. As HQLA cash receives an RSF factor of 0%, banks can make even more efficient NSFR adjustments by focusing on upwards adjustment of the cash component of their stock of HQLA. Furthermore, by increasing the stock of HQLA, banks can also improve their Liquidity Coverage Ratio since HQLA makes out the numerator of the LCR.

*Banks can reduce the Ratio of Total Lending to Total Assets*

Lending activities on a bank's balance sheet are subject to a rather penalizing RSF treatment. As a result of this, banks can improve their NSFRs by lowering their ratio of total lending to total assets.

*Banks can reduce the Ratio of Loan Types that receives a 100% Risk-Weight*

Banks can decrease their ratios of high-risk loan types to total assets as a mean to improve their NSFRs. It is evident that banks are decreasing the ratios of all loan types in periods where increases in their NSFRs are observed. The NSFR relevant adjustment is to decrease the high-risk loan types relatively more than the low-risk loan types.

Our analysis shows that these adjustments have been taking place since 2010, and that they are something that banks are doing in a significant relation to the yearly changes in their NSFRs. Thereby, the above proposals contain some of those adjustment strategies that banks might have been using up until now in terms of NSFR compliance.

## 9. Ideas for Further Research

Our investigation has focused on the driver capabilities of a specific set of balance sheet items that are included in the NSFR calculation methodology. We have selected these items based on their relevance for NSFR adjustments according to publications by different market participants. The fact is, that the NSFR calculation methodology comprises a very large number of balance sheet items. Among these, some are more relevant than others. A natural extension to our investigation would be to examine another set of balance sheet items. It is very likely the case, that banks are using other balance sheet items with the sole or partial purpose of NSFR compliance. We have already provided the data foundation and the NSFR calculation template for such an analysis.

Another analysis that might contribute with interesting insights would be to evaluate a set of year-based cross section regressions on our selected balance sheet items. In this way, it would be possible to compare significance, signs and magnitudes of the parameter estimates for each year since the announcement of the NSFR. In this way it would be possible to investigate which balance sheet adjustments banks are using year by year and possibly explain these changes in relation to developments in the financial markets or the macroeconomic landscape.

As a third proposal, it would be interesting to conduct a thorough analysis of the timing of bank's adjustments towards the NSFR as well as building a deeper understanding of the changes in the NSFR distribution. Such an analysis could answer a question like: *Which banks are adapting the quickest, and which are lagging behind?*

The NSFR liquidity requirement is a rather new topic within financial regulation and many questions regarding its implementation are still unanswered. As a part of this thesis, we have established a comprehensive overview of the previous publications on the NSFR as well as the data and information available. In relation to this, we believe that the area of NSFR accommodation is a natural subject for further investigation.

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## Appendices

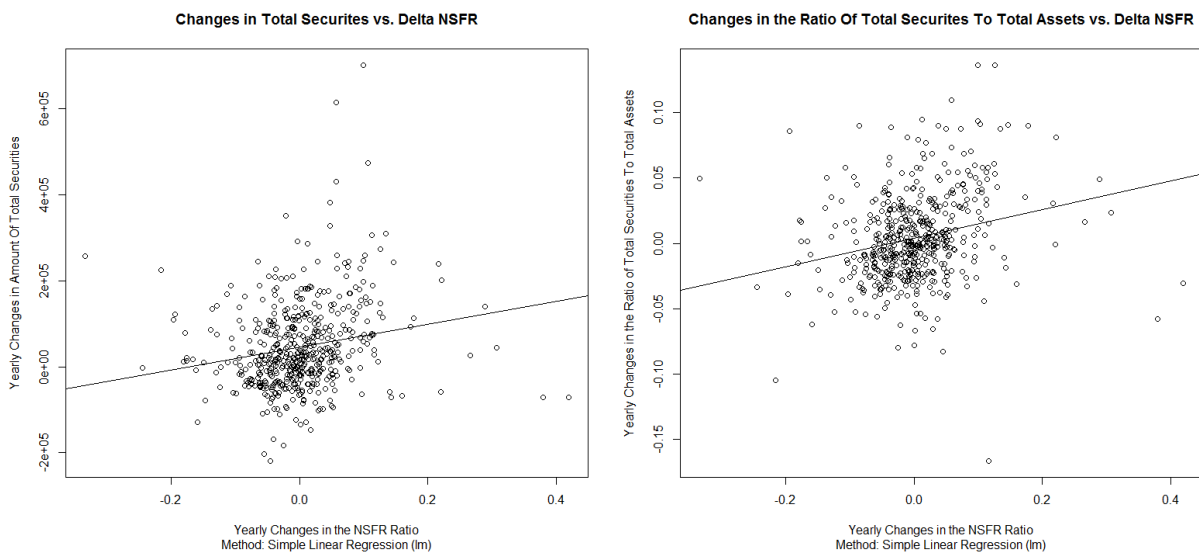
The appendix section provides additional analyses that have been carried out as an integrated part of our overall investigation. As a first part, it contains a graphical analysis of the scatter plots for our 8 different balance sheet items. Second, it contains a range of different tests that have been used for our panel data model construction. Third, it presents tests for inclusion or exclusion of particular control variables in our panel data model. Fourth, it provides the entire R code that have been used to conduct the investigation in terms of data set construction, descriptive statistics as well as regression modelling and testing.

### Appendix I: Scatter Plot Investigation

This appendix section provides a scatter plot analysis of our eight different balance sheet items. This investigation is intended to explore whether the inclusion of linear effects in our panel data model seems reasonable. The section will present scatter plots for each of the hypotheses, one by one, and comment on the findings in relation to the existence of linear pattern. In combinations with this, it will be evaluated whether any critical outliers or influential observations are present in the plots.

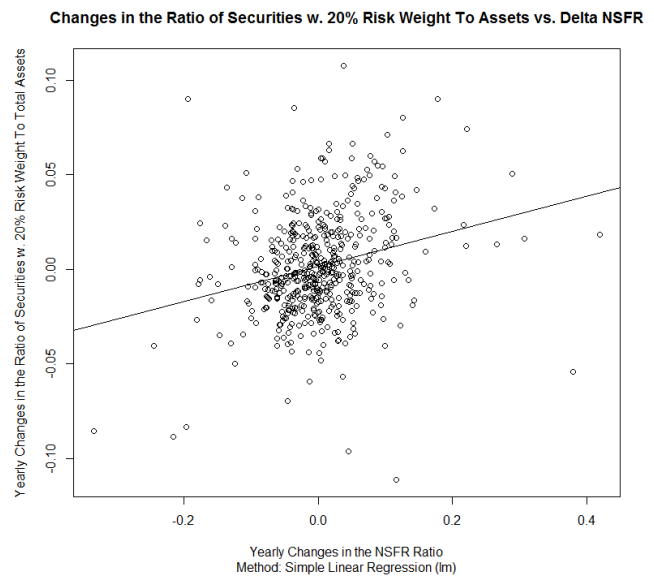
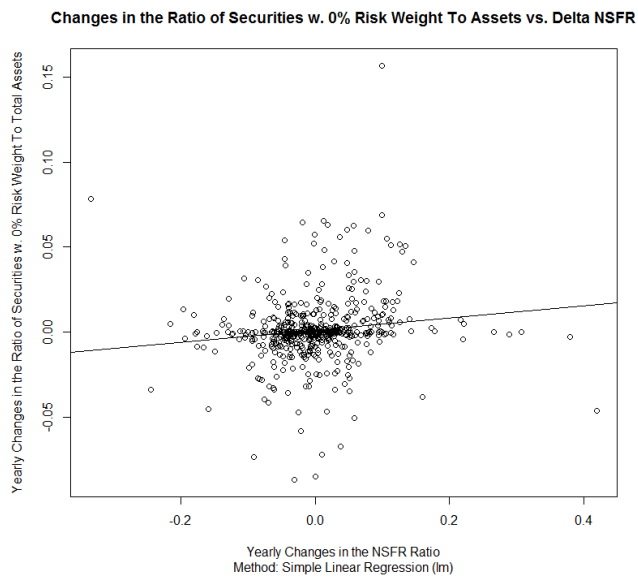
*Hypothesis 1: Banks' adjustment of the ratio of total securities to total assets is a significant driver of the yearly changes in the NSFR.*

A linear relationship seems to be present between “Yearly Changes in the NSFR Ratio” and “Yearly Changes in the Ratio of Total Securities to Total Assets”. In addition, it does not seem to be the case that there are any extreme observations.



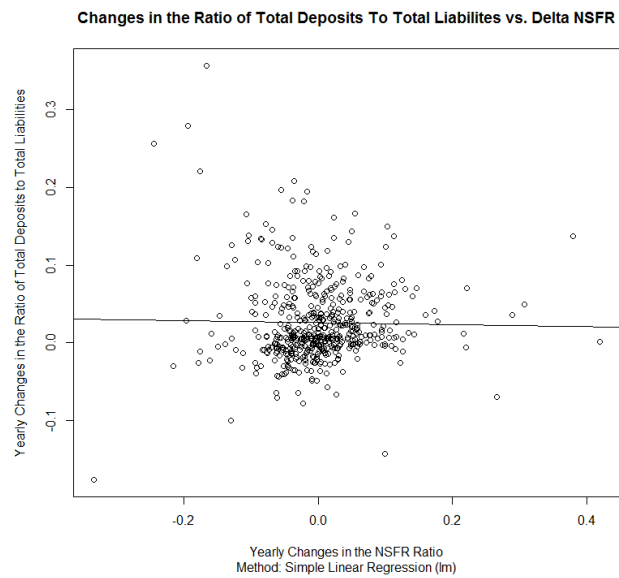
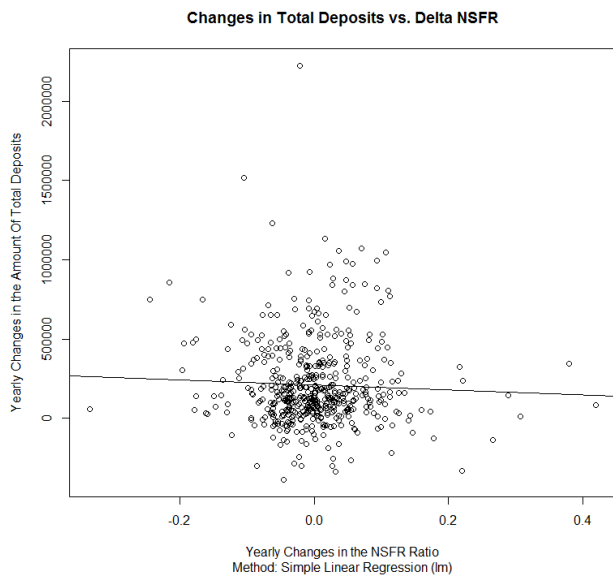
*Hypothesis 2: Banks' adjustment of their ratios of low-risk and high-risk securities to total assets is a significant driver of the yearly changes in the NSFR*

A linear relationship seems to be present between “Yearly Changes in the NSFR Ratio” and “Yearly Changes in the Ratio of Securities w. X% Risk Weight to Total Assets”. Also, none of the six scatter plots show any signs of extreme observations.



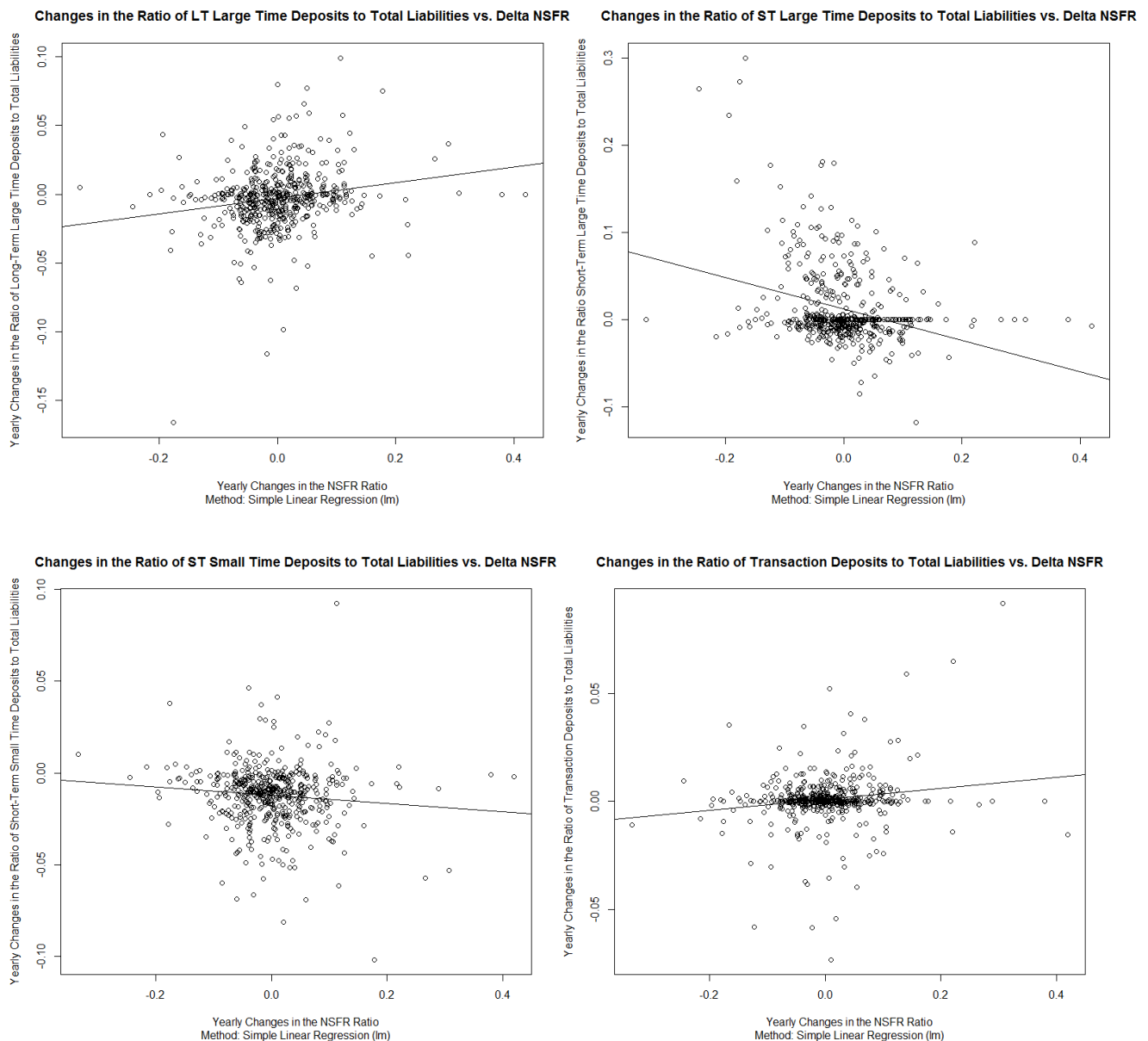
*Hypothesis 3: Banks' adjustment of the ratio of total deposits to total liabilities is a significant driver of the yearly changes in the NSFR*

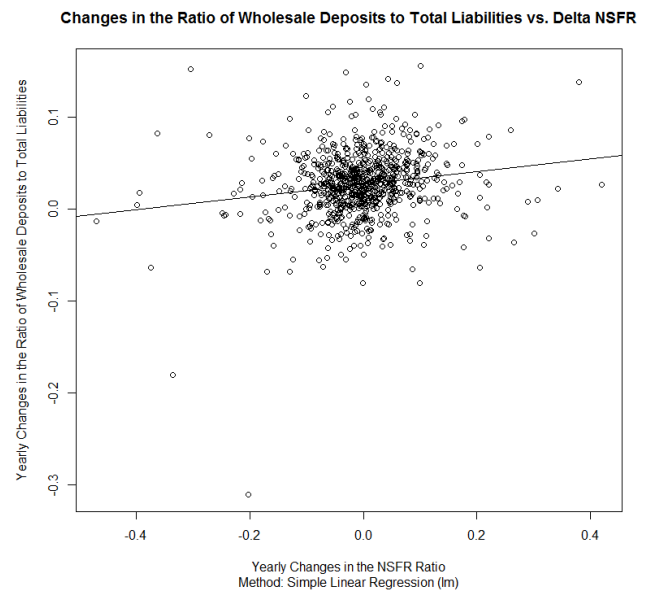
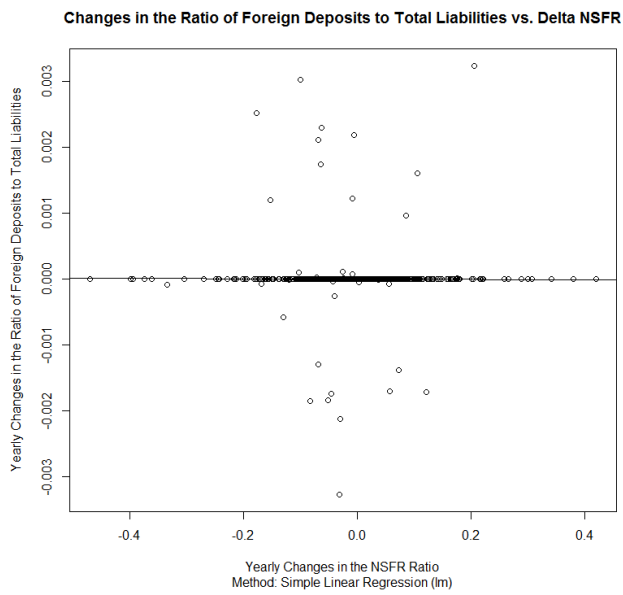
A linear relationship seems to be present between “Yearly Changes in the NSFR Ratio” and “Yearly Changes in the Ratio of Total Deposits to Total Liabilities”. In addition, there are no signs of extreme observations.



*Hypothesis 4: Bank's adjustment of their ratios of low-risk and high-risk deposit types to total liabilities is a significant driver of the yearly changes in the NSFR*

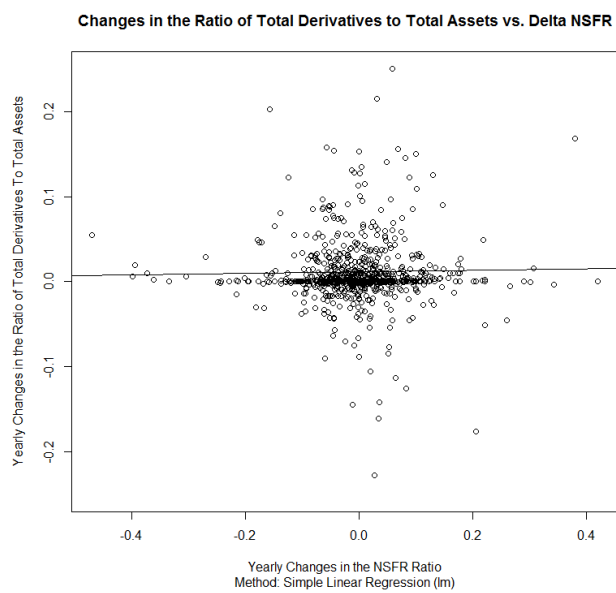
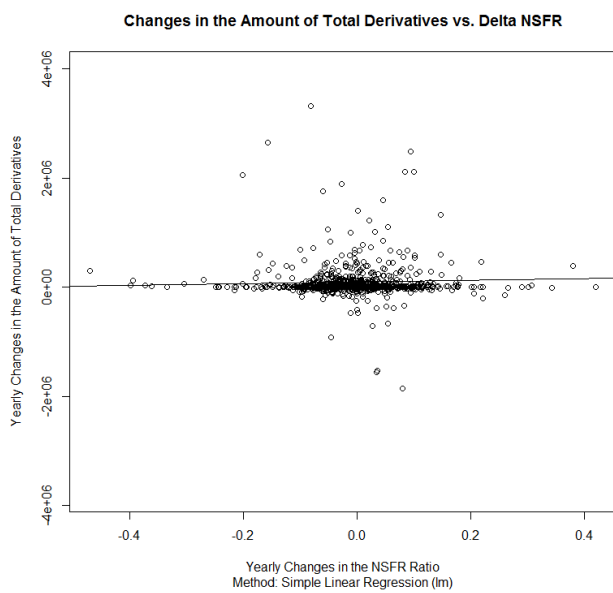
A linear relationship seems to be present between “Yearly Changes in the NSFR Ratio” and “Yearly Changes in X Deposits to Total Liabilities”. In addition, there are no signs of extreme observations.





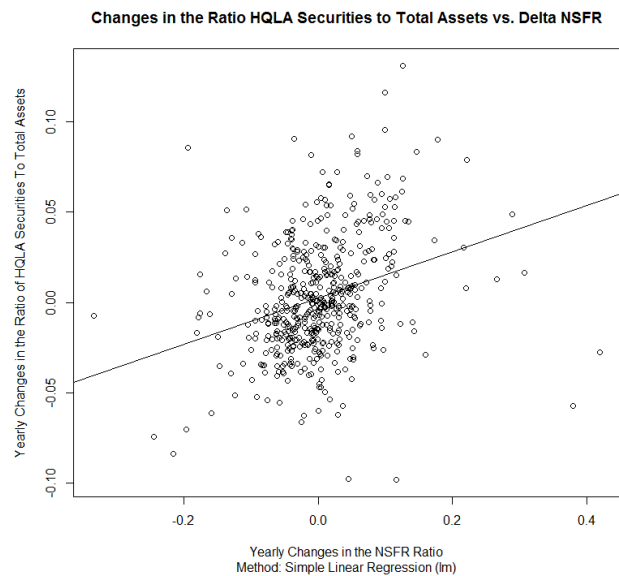
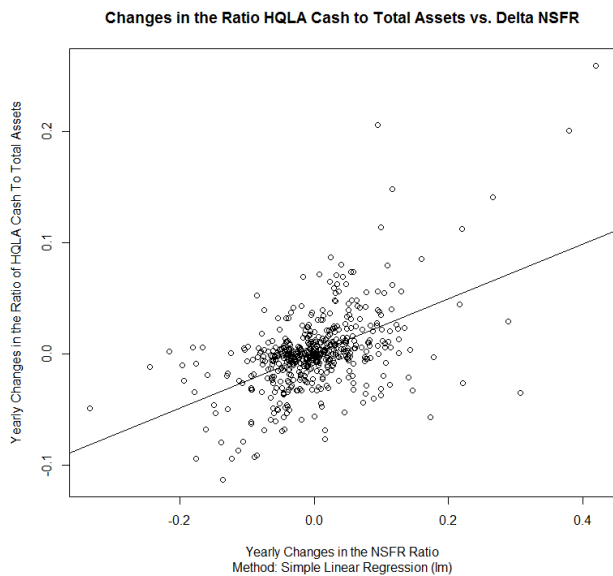
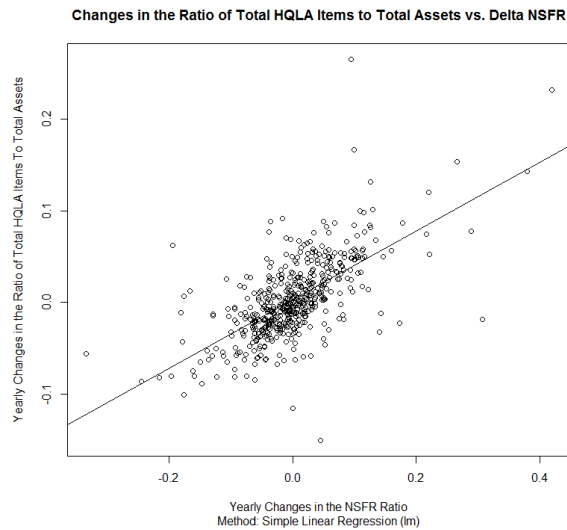
*Hypothesis 5: Banks' adjustment of the ratio of total derivatives to total assets is a significant driver of the yearly changes in the NSFR.*

A linear relationship is present between “Yearly Changes in the NSFR Ratio” and “Yearly Changes in the Ratio of Total Derivatives to Total Assets”. In addition, there are no signs of extreme observations.



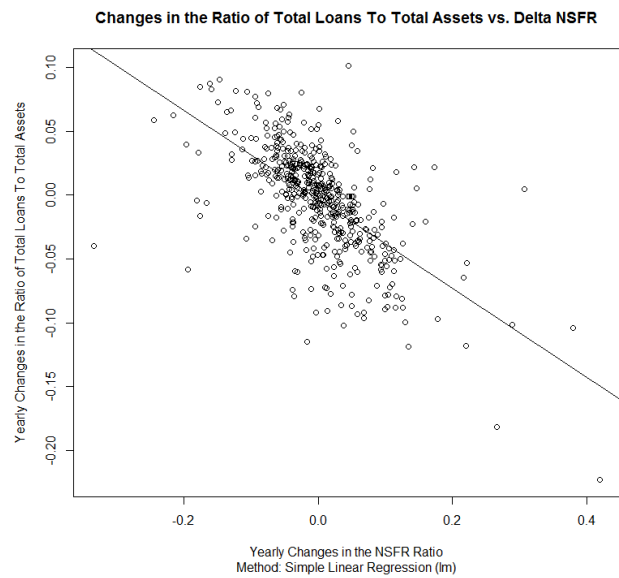
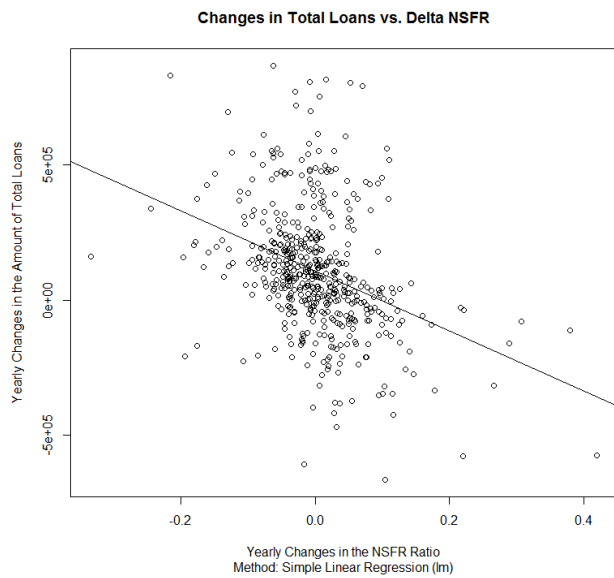
*Hypothesis 6: Banks' adjustment of the ratio of high-quality liquid assets to total assets is a significant driver of the yearly changes in the NSFR.*

A linear relationship seems to be present between “Yearly Changes in the NSFR Ratio” and “Yearly Changes in the Ratio of Total HQLA Assets to Total Assets”. In addition, there are no signs of extreme observations.



*Hypothesis 7: Banks' adjustment of the ratio of total lending to total assets is a significant driver of the yearly changes in the NSFR.*

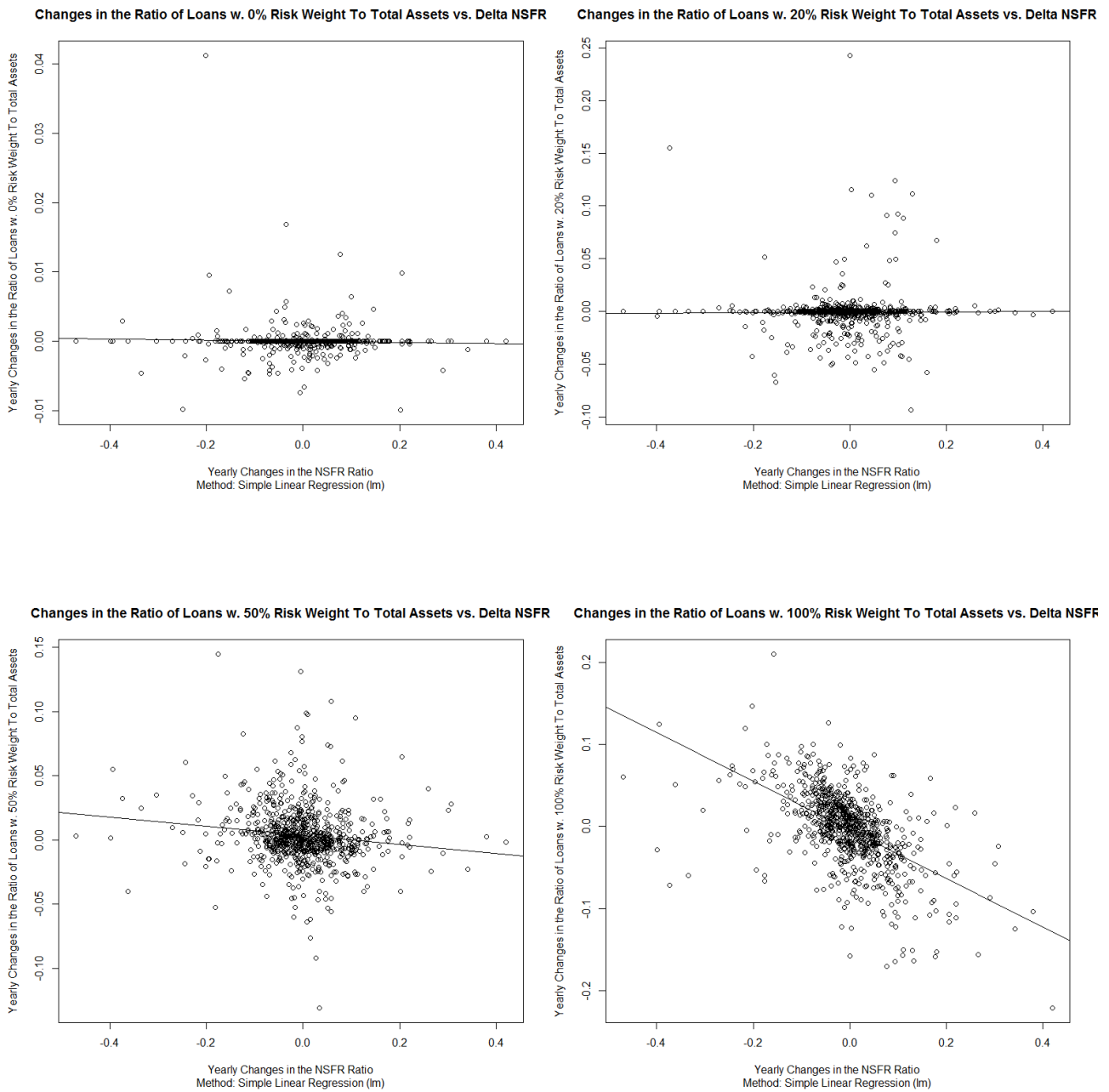
A linear relationship seems to be present between “Yearly Changes in the NSFR Ratio” and “Yearly Changes in the Ratio of Total Loans to Total Assets”. In addition, there are no signs of extreme observations.





*Hypothesis 8: Banks adjustment of their ratios of different risk-segmented loan types to total assets is a significant driver of the yearly changes in the NSFR*

A linear relationship seems to be present between “Yearly Changes in the NSFR Ratio” and “Yearly Changes in the Ratio of Total HQLA Assets to Total Assets”. For the plots of low-risk security types there are signs of potentially extreme observations. However, for the high-risk security types, there are no signs of extreme observations.



## Appendix II: Hausman Test for Estimator Choice

This section exemplifies the Hausman testing procedure for proper estimation choice for the securities hypothesis (Hypothesis 1):

*Banks' adjustment of the ratio of total securities to total assets is a significant driver of the yearly changes in the NSFR.*

The Hausman test is based on the difference between the RE and FE estimates. In the case where the error term is correlated with the explanatory variables, the FE estimator will be consistent whereas the RE estimator will be inconsistent. Based on this, a statistically significant difference in the estimates can be interpreted as a evidence against the assumptions underlying the application of the RE estimator, namely the non-existence of correlation between the covariates and the error terms. In this way, the Hausman test implicitly works as a formal test for endogeneity in our specified model.<sup>154</sup>

$H_0$ : No significant difference in estimates: Both estimators are consistent, but RE is most efficient

$H_1$ : Significant difference in estimates, RE is inconsistent

The test is calculated as a Chi-squared statistic and is evaluated under the corresponding distribution.

$$\text{Hausman Statistic} = (\hat{\beta}_{RE} - \hat{\beta}_{FE})^T * \left( \text{Var}(\hat{\beta}_{FE}) - \text{Var}(\hat{\beta}_{FE}) \right)^{-1} * (\hat{\beta}_{RE} - \hat{\beta}_{FE})$$

The specific test can be conducted by using the plm package<sup>155</sup> in R. The model specification for the final securities regression model and the test results are shown below.

---

<sup>154</sup> Wooldridge. M. Jeffrey, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press, Second Edition, 2010, Page 328-329.

<sup>155</sup> Croissant, Yves. Millo, Giovanni, *Panel Data Econometrics in R: The plm package*, 2009, Journal of Statistical Software. vol. 27, Page 2.

```

> M1 <- HV51DeltaTotalSecurities ~ Delta.NSFR+Delta.Leverage.Ratio+Lagged.LR.Deficit
> m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
> summary(m1)
Oneway (individual) effect Within Model

Call:
plm(formula = M1, data = paneldata, effect = "individual", model = "within")

Unbalanced Panel: n=161, T=4-5, N=765

Residuals :
      Min.   1st Qu.   Median   3rd Qu.    Max.
-2250000   -93000    -3000     84600   3090000

Coefficients :
              Estimate Std. Error t-value Pr(>|t|)
Delta.NSFR          848742    165912   5.1156 4.212e-07 ***
Delta.Leverage.Ratio -9852719    1217295 -8.0939 3.215e-15 ***
Lagged.LR.Deficit     9558846    1247494   7.6624 7.348e-14 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    9.1353e+13
Residual Sum of Squares: 7.7432e+13
R-Squared      : 0.15239
Adj. R-Squared : 0.11972
F-statistic: 36.0185 on 3 and 601 DF, p-value: < 2.22e-16
> FEmodel <- plm(M1, data = paneldata, effect = "individual", model = "within")
> REmodel <- plm(M1, data = paneldata, effect = "individual", model = "random")
> phtest(FEmodel, REmodel)

      Hausman Test

data:  M1
chisq = 21.279, df = 3, p-value = 9.213e-05
alternative hypothesis: one model is inconsistent

```

As can be observed, the p-value of the Hausman statistic is well below the threshold value of 5%. This leads to a rejection of the null hypothesis, that there is no significant difference in the estimates provided by the different estimators. This leaves us with the alternative hypothesis, that the FE estimator is the consistent estimator for our purposes.

### Appendix III: Test for Macro Variable Exclusion

As outlined in the section on "Choice of Econometric Model" it has been chosen to exclude macroeconomic variables in order to allow for the inclusion of the four time dummy variables. The argument is that the three macroeconomic control variables can be constructed as direct linear combinations of the four time dummies. Furthermore, it turns out that the information contained in the macroeconomic control variables are contained in the time dummies.

```
> anova(mtimefull,mmacrofull)
Analysis of Variance Table

Model 1: HV31DeltaTotalLoans ~ Delta.NSFR + Lagged.NSFR.Deficit + Delta.LCR +
  Lagged.LCR.Deficit + Delta.Leverage.Ratio + Lagged.LR.Deficit +
  Total.Assets + X2011Dummy + X2012Dummy + X2013Dummy + X2014Dummy
Model 2: HV31DeltaTotalLoans ~ Delta.NSFR + Lagged.NSFR.Deficit + Delta.LCR +
  Lagged.LCR.Deficit + Delta.Leverage.Ratio + Lagged.LR.Deficit +
  Total.Assets + GDP.2009.Chained + CPI + Risk.Free.Rate
   Res.Df    RSS Df    Sum of Sq    F Pr(>F)
1      753 2.6537e+14
2      754 2.6605e+14 -1 -6.8147e+11 1.9337 0.1648
```

When comparing two different models in an ANOVA test, the parameters of the variables included from the to the second model are tested for their joint significance according to the following set of hypotheses.

$$H_0: \beta_{GDP.2009.Chained} = \beta_{CPI} = \beta_{InterestRate} = 0$$

$$H_1: \text{At least one of the betas in } H_0 \text{ is different from 0}$$

As can be seen from the test output, the p-value is well above the 5% threshold thereby indicating that the null hypothesis cannot be rejected at a 5% significance level. This tells us that the information contained in the three macroeconomic variables is not adding any value as long as we include the time dummies instead.

## Appendix IV: Tests for Autocorrelation in Error Terms

As a part of the assessment of estimation techniques it is necessary to examine the fixed effects models for autocorrelation in their error terms. If the estimated models display any sort of autocorrelation a first differencing procedure will have to be implemented in order to eliminate the systematic behavior of the error terms. This autocorrelation can be examined in different ways. We have chosen to conduct Breusch-Godfrey tests following the *plm* package<sup>156</sup> in R.

By conducting Breusch-Godfrey test for autocorrelation in the error terms at lag one and lag 2 we can examine the following hypothesis for  $h = 1$  and  $h = 2$  lags.<sup>157</sup>

$H_0$ : No autocorrelation at lag  $h$

$H_1$ : Autocorrelation at lag  $h$

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<sup>156</sup> Croissant, Yves. Millo, Giovanni, *Panel Data Econometrics in R: The plm package*, 2009, Journal of Statistical Software. vol. 27, 2.

<sup>157</sup> Autocorrelation is most common at lag 1 or lag 2. It is very rare to discover autocorrelation at larger lags. However, plots of the autocorrelation function has been examined as well, in order to check for autocorrelation patterns at much larger lags.

```

> M1 <- HV51DeltaTotalSecurities ~ Delta.NSFR+Delta.Leverage.Ratio+Lagged.LR.Deficit
> m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
> summary(m1)
Oneway (individual) effect Within Model

Call:
plm(formula = M1, data = paneldata, effect = "individual", model = "within")

Unbalanced Panel: n=161, T=4-5, N=765

Residuals :
      Min.   1st Qu.   Median   3rd Qu.    Max.
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Coefficients :
              Estimate Std. Error t-value Pr(>|t|)
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Delta.Leverage.Ratio -9852719    1217295 -8.0939 3.215e-15 ***
Lagged.LR.Deficit    9558846    1247494   7.6624 7.348e-14 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    9.1353e+13
Residual Sum of Squares: 7.7432e+13
R-Squared      : 0.15239
Adj. R-Squared : 0.11972
F-statistic: 36.0185 on 3 and 601 DF, p-value: < 2.22e-16
>
> pbgttest(m1, order=1)

Breusch-Godfrey/Wooldridge test for serial correlation in panel models

data: M1
chisq = 41.378, df = 1, p-value = 0.12157
alternative hypothesis: serial correlation in idiosyncratic errors

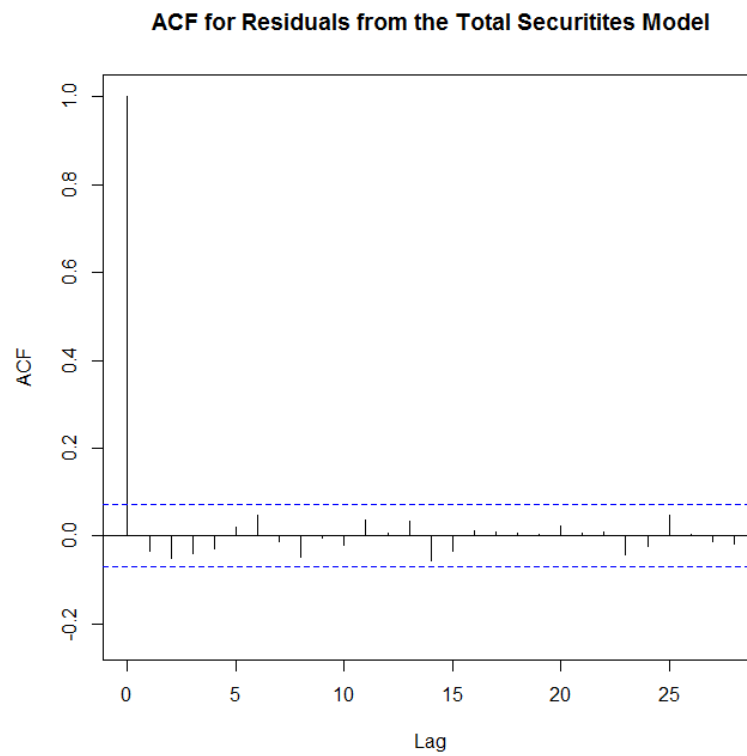
> pbgttest(m1, order=2)

Breusch-Godfrey/Wooldridge test for serial correlation in panel models

data: M1
chisq = 62.282, df = 2, p-value = 0.09704
alternative hypothesis: serial correlation in idiosyncratic errors

```

Furthermore, we have examined the autocorrelation functions between the residual series and its own lagged edition for a range of lags from 1 to 25. For each model estimated on a fixed effects basis there is no signs of significant autocorrelation at a 5% significance level.



From the ACF plot it is observed that the autocorrelation values does not reach outside the horizontal 95% confidence lines. This indicates that there is no significant autocorrelation at any of the specified lags 1 to 30.

## Appendix V: Assets Qualifying for a 15 Percent RSF Factor

Assets qualifying for a 15 percent RSF factor in the NSFR framework are so-called Level 2A assets as defined in paragraph 52 the LCR framework. These Level 2A assets divide themselves into three main categories: Marketable securities, corporate debt securities and other unencumbered loans to financial institutions with a residual maturity of less than six months.<sup>158</sup>

Marketable securities will have to represent claims on, or be guaranteed by, sovereigns, central banks, PSEs or multilateral development banks. In addition, each single marketable security must meet a range of specific criteria: The first requirement is that the given asset has been assigned a 20 percent risk-weight under the Basel II Standardized Approach for credit risk. Second, a Level 2A asset must be traded in large, deep and active repo or cash markets. Third, these assets must have proven to be a reliable source of liquidity in the repo or sales markets during times of financial stress. The reliability criteria is defined as a decline in price, or increase in haircut, of maximum 20 percent during a period of 30 days characterized by liquidity stress. Fourth, the Level 2A assets may not be an obligation of a financial institution or any of its affiliated entities.<sup>159</sup>

Corporate debt securities include commercial papers and covered bonds, and will have to meet a list of requirements in order to be eligible for a Level 2A asset classification. First of all, the corporate debt securities may not have been issued by a financial institution or any of its affiliated entities. In the case of covered bonds, these may not have been issued by the bank itself or any of its affiliated entities. Second, the corporate debt securities must have a long-term credit rating from a well-renowned external credit assessment institution of at least AA-. In the absence of a long-term external credit rating a short-term rating equivalent in quality to the long-term rating can work as a substitute. In the case where the corporate debt security does not have a valid rating from a recognized external credit assessment institution, it will have to meet an alternative requirement based on the security's probability of default. This probability of default will have to correspond to a credit rating of at least AA. Similarly to the marketable securities, the corporate debt securities must be traded in large, deep and active repo or cash markets that are characterized by a low level of concentration. Third, the corporate debt securities must have proven to be a reliable source of

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<sup>158</sup> Basel Committee on Banking Supervision, Basel III: *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), January 2013, Page 19.

<sup>159</sup> Basel Committee on Banking Supervision, Basel III: *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), January 2013, Page 19.



liquidity in the repo or sales markets even during times of financial stress.<sup>160</sup> For some qualifying asset classes in certain jurisdictions there might not exist large, deep and active repo or cash markets. In this case, the assets will likely be monetized through direct sale. As a part of this, any given bank should exclude those assets that are under large fire-sale discounts.<sup>161</sup>

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<sup>160</sup> Basel Committee on Banking Supervision, Basel III: *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, Paragraph 52, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), January 2013, Page 19.

<sup>161</sup> Basel Committee on Banking Supervision, Basel III: *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, Paragraph 38, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), January 2013, Page 16.

## Appendix VI: Assets Qualifying for a 50 Percent RSF Factor

The asset category that qualifies for a 50 percent RSF factor comprises a large range of financial items. One of these items is the unencumbered Level 2B assets as described in paragraph 54 of the LCR framework. The Level 2B asset classification consists of residential mortgage backed securities (RMBS), corporate debt securities and common equity shares.<sup>162</sup>

Each of these Level 2B asset types will have to meet a range of criteria in order to be assigned a 50 percent RSF factor. Residential mortgage backed securities can be included as Level 2B assets subject to a 25 percent haircut if they meet the following range of criteria: First, the securities may not have been issued by the bank itself or any of its affiliated entities. Second, they must have a long-term credit rating provided by a recognized external credit assessment institution of at least AA. If a recognized credit rating does not exist, then a short-term rating similar in quality to the long-term rating can be used as an alternative. Third, the residential mortgage backed securities will have to be traded in large, deep and active repo or cash markets characterized by a low level of concentration. Fourth, the securities must have proven a clear record as a reliable source of liquidity in the repo or sales markets even during times of severe financial stress. This reliability is defined as a decline in price or increase in haircut of maximum 20 percent over a 30-day period characterized by liquidity stress. Fifth, the underlying asset pool for the securities may only contain residential mortgages and cannot include any type of structured products. Furthermore, these underlying mortgages must be so-called full recourse loans. This means that the mortgage owner will have to remain liable for any potential shortfall in the sales proceeds from the given property in the case of foreclosure.<sup>163</sup>

Corporate debt securities include commercial papers and can be classified as a Level 2B asset subject to a 50 percent haircut if they meet four specific criteria as listed in paragraph 54 of the LCR framework. First, the securities may not have been issued by a financial institution or any of its affiliated entities. Second, the securities must have a long-term credit rating from an external credit assessment institution ranging from A+ to BBB-. In the case that a long-term rating is not provided, a short-term rating of the same quality as the long-term rating can be used as an alternative. Third, the corporate debt securities must be traded in large, deep and active repo or cash

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<sup>162</sup> Basel Committee on Banking Supervision, Basel III: *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, Paragraph 54, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), January 2013, Page 20.

<sup>163</sup> Basel Committee on Banking Supervision, Basel III: *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), January 2013, Page 20.

markets that are characterized by a low level of concentration. Fourth, the corporate debt securities, as with the residential mortgage backed securities, must have proven themselves to be a reliable source of liquidity in the repo or sales markets during stressed market conditions. As for the RMBSs, the definition of reliability under a stressed market setting is a decline in price or increase in haircut of maximum 20 percent during 30 days of liquidity stress.<sup>164</sup>

Common equity shares can similar to corporate debt securities be included subject to a 50 percent haircut, if they meet the following six criteria as listed in paragraph 54 of the LCR framework. First of all, the common equity shares may not have been issued by a financial institution or any of its affiliated entities. Second, the common equity shares must be exchange traded and centrally cleared. Third, the shares must be a constituent of a major stock index in the home jurisdiction or at the place where the liquidity risk is held. Whether the shares meet this third criteria, will be decided by the supervisor of the jurisdiction at the location where the major stock index is located. Fourth, the shares will have to be denominated in the domestic currency of the home jurisdiction of the bank, or alternatively in the currency of the specific jurisdiction where the bank's liquidity risk is held. Fifth, the shares will have to be traded in large, deep and active repo or cash markets which are characterized by a low level of concentration. This is equivalent to the other Level 2B asset classes. Lastly, the shares must have proven themselves to be a reliable source of liquidity even during times of severe financial market stress. The reliability criteria is defined as a decline in price or an increase in haircut of maximum 40 percent during a 30-day period of liquidity stress.<sup>165</sup>

A last item that can be included in this RSF category will be deposits that are held for operational purposes at other financial institutions. These should be subject to the 50 percent ASF factor as described in paragraphs 93-104 of the LCR framework.<sup>166</sup>

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<sup>164</sup> Basel Committee on Banking Supervision, Basel III: *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), January 2013, Page 20.

<sup>165</sup> Basel Committee on Banking Supervision, Basel III: *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), January 2013, Page 20.

<sup>166</sup> Basel Committee on Banking Supervision, Basel III: *The Liquidity Coverage Ratio and liquidity risk monitoring tools*, Paragraphs 93-104, Bank for International Settlements (BIS), [www.bis.org](http://www.bis.org), January 2013, Pages 30-32.

## Appendix VI: R Codes

\*\*\*\*\*

### LOADING TOOLS

\*\*\*\*\*

```
rm(list=ls())
```

```
install.packages("Formula")
install.packages("bdsmatrix")
install.packages("zoo")
install.packages("sandwich")
install.packages("foreign")
install.packages("xts")
install.packages("miscTools")
install.packages("maxLik")
install.packages("lmtest")
install.packages("plm")
install.packages("pglm")
install.packages("aod")
install.packages("stats")
install.packages("car")
install.packages("stargazer")
```

```
library(stargazer)
library("Formula")
library("bdsmatrix")
library("zoo")
library("sandwich")
library("foreign")
library("xts")
library("miscTools")
library("maxLik")
library("lmtest")
library("plm")
library("pglm")
library("aod")
library("stats")
library("car")
```

\*\*\*\*\*

### DATA FRAMING

\*\*\*\*\*

```
setwd("C:/Users/Sandfeld/Desktop")
```

```
datafile <- read.delim2("NSFRDataLCRFILTER160.txt", header = TRUE)
Variables <- as.vector(colnames(datafile))
Variables
```

```
paneldata <- pdata.frame(datafile, index = c("Bank.ID", "Year"), drop.index=TRUE, row.names=TRUE)
head(paneldata)
head(attr(paneldata, "index"))
VariablesPanel <- as.vector(colnames(paneldata))
VariablesPanel
```

```
*****
EXPLORATIVE ANALYSIS FOR BALANCE SHEET ITEMS - SCATTER PLOTS
*****
```

```
par(mfrow=c(1,2))
```

```
*****HQLA*****
```

```
plot(Delta.NSFR,HV42DeltaRatioOfHQLAToTotalLiabilites, data = paneldata, main="Changes in the Ratio of Total
HQLA Items to Total Assets vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)", xlab="Yearly Changes
in the NSFR Ratio",
ylab="Yearly Changes in the Ratio of Total HQLA Items To Total Assets")
z <- lm(HV42DeltaRatioOfHQLAToTotalLiabilites~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV1DeltaRatioOfHQLACashToTotalLiabilities, data = paneldata, main="Changes in the Ratio
HQLA Cash to Total Assets vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)", xlab="Yearly Changes in
the NSFR Ratio",
ylab="Yearly Changes in the Ratio of HQLA Cash To Total Assets")
z <- lm(HV1DeltaRatioOfHQLACashToTotalLiabilities~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV2DeltaRatioOfHQLASecuritiesToTotalLiabilites, data = paneldata, main="Changes in the Ratio
HQLA Securities to Total Assets vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)", xlab="Yearly
Changes in the NSFR Ratio",
ylab="Yearly Changes in the Ratio of HQLA Securities To Total Assets")
z <- lm(HV2DeltaRatioOfHQLASecuritiesToTotalLiabilites~Delta.NSFR, data = paneldata)
abline(z)
```

```
*****LOANS*****
```

```
plot(Delta.NSFR,HV31DeltaTotalLoans, data = paneldata, main="Changes in Total Loans vs. Delta NSFR",
sub="Method: Simple Linear Regression (lm)", xlab="Yearly Changes in the NSFR Ratio",
ylab="Yearly Changes in the Amount of Total Loans")
z <- lm(HV31DeltaTotalLoans~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV43DeltaRatioOfTotalLoansToTotalAssets, data = paneldata, main="Changes in the Ratio of Total
Loans To Total Assets vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)", xlab="Yearly Changes in the
NSFR Ratio",
ylab="Yearly Changes in the Ratio of Total Loans To Total Assets" )
z <- lm(HV43DeltaRatioOfTotalLoansToTotalAssets~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV27DeltaRatioOfLoans0RWToTotalAssets, data = paneldata, main="Changes in the Ratio of Loans
w. 0% Risk Weight To Total Assets vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)", xlab="Yearly
Changes in the NSFR Ratio",
ylab="Yearly Changes in the Ratio of Loans w. 0% Risk Weight To Total Assets" )
z <- lm(HV27DeltaRatioOfLoans0RWToTotalAssets~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV28DeltaRatioOfLoans20RWToTotalAssets, data = paneldata, main="Changes in the Ratio of
Loans w. 20% Risk Weight To Total Assets vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)",
xlab="Yearly Changes in the NSFR Ratio",
ylab="Yearly Changes in the Ratio of Loans w. 20% Risk Weight To Total Assets" )
z <- lm(HV28DeltaRatioOfLoans20RWToTotalAssets~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV29DeltaRatioOfLoans50RWToTotalAssets, data = paneldata, main="Changes in the Ratio of
Loans w. 50% Risk Weight To Total Assets vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)",
xlab="Yearly Changes in the NSFR Ratio",
ylab="Yearly Changes in the Ratio of Loans w. 50% Risk Weight To Total Assets" )
z <- lm(HV29DeltaRatioOfLoans50RWToTotalAssets~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV30DeltaRatioOfLoans100RWToTotalAssets, data = paneldata, main="Changes in the Ratio of
Loans w. 100% Risk Weight To Total Assets vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)",
xlab="Yearly Changes in the NSFR Ratio",
ylab="Yearly Changes in the Ratio of Loans w. 100% Risk Weight To Total Assets" )
z <- lm(HV30DeltaRatioOfLoans100RWToTotalAssets~Delta.NSFR, data = paneldata)
abline(z)
```

\*\*\*\*\*SECURITIES\*\*\*\*\*

```
plot(Delta.NSFR,HV51DeltaTotalSecurities, data = paneldata, main="Changes in Total Securites vs. Delta NSFR",
sub="Method: Simple Linear Regression (lm)", xlab="Yearly Changes in the NSFR Ratio",
ylab="Yearly Changes in Amount Of Total Securities")
z <- lm(HV51DeltaTotalSecurities~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV45DeltaRatioOfTotalSecuritiesToTotalAssets, data = paneldata, main="Changes in the Ratio Of
Total Securites To Total Assets vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)", xlab="Yearly
Changes in the NSFR Ratio",
ylab="Yearly Changes in the Ratio of Total Securities To Total Assets")
z <- lm(HV45DeltaRatioOfTotalSecuritiesToTotalAssets~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV37DeltaRatioOfSecuritiesToTotalAssets0RW, data = paneldata, main="Changes in the Ratio of
Securities w. 0% Risk Weight To Assets vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)",
xlab="Yearly Changes in the NSFR Ratio",
ylab="Yearly Changes in the Ratio of Securities w. 0% Risk Weight To Total Assets")
z <- lm(HV37DeltaRatioOfSecuritiesToTotalAssets0RW~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV38DeltaRatioOfSecuritiesToTotalAssets20RW, data = paneldata, main="Changes in the Ratio of
Securities w. 20% Risk Weight To Assets vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)",
xlab="Yearly Changes in the NSFR Ratio",
ylab="Yearly Changes in the Ratio of Securities w. 20% Risk Weight To Total Assets")
z <- lm(HV38DeltaRatioOfSecuritiesToTotalAssets20RW~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV39DeltaRatioOfSecuritiesToTotalAssets50RW, data = paneldata, main="Changes in the Ratio of
Securities w. 50% Risk Weight To Assets vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)",
xlab="Yearly Changes in the NSFR Ratio",
ylab="Yearly Changes in the Ratio of Securities w. 50% Risk Weight To Total Assets")
z <- lm(HV39DeltaRatioOfSecuritiesToTotalAssets50RW~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV40DeltaRatioOfSecuritiesToTotalAssets100RW, data = paneldata, main="Changes in the Ratio of
Securities w. 100% Risk Weight To Assets vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)",
xlab="Yearly Changes in the NSFR Ratio",
ylab="Yearly Changes in the Ratio of Securities w. 100% Risk Weight To Total Assets")
z <- lm(HV40DeltaRatioOfSecuritiesToTotalAssets100RW~Delta.NSFR, data = paneldata)
abline(z)
```

\*\*\*\*\*DEPOSITS\*\*\*\*\*

```
plot(Delta.NSFR,HV32DeltaTotalDeposits, data = paneldata, main="Changes in Total Deposits vs. Delta NSFR",
sub="Method: Simple Linear Regression (lm)", xlab="Yearly Changes in the NSFR Ratio",
ylab="Yearly Changes in the Amount Of Total Deposits")
z <- lm(HV32DeltaTotalDeposits~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV52DeltaRatioOfTotalDepositstoTotalAssets, data = paneldata, main="Changes in the Ratio of
Total Deposits To Total Liabilites vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)", xlab="Yearly
Changes in the NSFR Ratio",
ylab="Yearly Changes in the Ratio of Total Deposits to Total Liabilities")
z <- lm(HV52DeltaRatioOfTotalDepositstoTotalAssets~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV53DeltaRatioOfLongTermLargeTimeDeposits, data = paneldata, main="Changes in the Ratio of
LT Large Time Deposits to Total Liabilities vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)",
xlab="Yearly Changes in the NSFR Ratio",
ylab="Yearly Changes in the Ratio of Long-Term Large Time Deposits to Total Liabilities")
z <- lm(HV53DeltaRatioOfLongTermLargeTimeDeposits~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV54DeltaRatioOfShortTermLargeTimeDeposits, data = paneldata, main="Changes in the Ratio of
ST Large Time Deposits to Total Liabilities vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)",
xlab="Yearly Changes in the NSFR Ratio",
ylab="Yearly Changes in the Ratio Short-Term Large Time Deposits to Total Liabilities")
z <- lm(HV54DeltaRatioOfShortTermLargeTimeDeposits~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV55DeltaRatioOfShortTermSmallTimeDeposits, data = paneldata, main="Changes in the Ratio of
ST Small Time Deposits to Total Liabilities vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)",
xlab="Yearly Changes in the NSFR Ratio",
ylab="Yearly Changes in the Ratio of Short-Term Small Time Deposits to Total Liabilities")
z <- lm(HV55DeltaRatioOfShortTermSmallTimeDeposits~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV56DeltaRatioOfTransactionDeposits, data = paneldata, main="Changes in the Ratio of Transaction
Deposits to Total Liabilities vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)", xlab="Yearly Changes in
the NSFR Ratio",
ylab="Yearly Changes in the Ratio of Transaction Deposits to Total Liabilities")
z <- lm(HV56DeltaRatioOfTransactionDeposits~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV57DeltaRatioOfForeignDeposits, data = paneldata, main="Changes in the Ratio of Foreign
Deposits to Total Liabilities vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)", xlab="Yearly Changes in
the NSFR Ratio",
ylab="Yearly Changes in the Ratio of Foreign Deposits to Total Liabilities")
z <- lm(HV57DeltaRatioOfForeignDeposits~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV58DeltaRatioOfWholesaleDeposits, data = paneldata, main="Changes in the Ratio of Foreign
Deposits to Total Liabilities vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)", xlab="Yearly Changes in
the NSFR Ratio",
ylab="Yearly Changes in the Ratio of Wholesale Deposits to Total Liabilities")
z <- lm(HV58DeltaRatioOfWholesaleDeposits~Delta.NSFR, data = paneldata)
abline(z)
```

\*\*\*\*\*BALANCE SHEET SHRINKAGE - TOTAL ASSETS\*\*\*\*\*

```
plot(Delta.NSFR,DTTotalAssets, data = paneldata, main="Changes in the Amount of Total Assets vs. Delta NSFR",
sub="Method: Simple Linear Regression (lm)", xlab="Yearly Changes in the NSFR Ratio",
ylab="Yearly Changes in the Amount ofTotal Assets")
z <- lm(DTotalAssets~Delta.NSFR, data = paneldata)
abline(z)
```

\*\*\*\*\*DERIVATIVES\*\*\*\*\*

```
plot(Delta.NSFR,HV26DeltaTotalDerivatives, data = paneldata, ylim=c(-3800000,4000000), main="Changes in the
Amount of Total Derivatives vs. Delta NSFR", sub="Method: Simple Linear Regression (lm)", xlab="Yearly Changes
in the NSFR Ratio",
ylab="Yearly Changes in the Amount of Total Derivatives")
z <- lm(HV26DeltaTotalDerivatives~Delta.NSFR, data = paneldata)
abline(z)
```

```
plot(Delta.NSFR,HV41DeltaRatioOfTotalDerivativesToTotalAssets, data = paneldata, ylim=c(-
0.25,0.25),main="Changes in the Ratio of Total Derivatives to Total Assets vs. Delta NSFR", sub="Method: Simple
Linear Regression (lm)", xlab="Yearly Changes in the NSFR Ratio",
ylab="Yearly Changes in the Ratio of Total Derivatives To Total Assets")
z <- lm(HV41DeltaRatioOfTotalDerivativesToTotalAssets~Delta.NSFR, data = paneldata)
abline(z)
```

\*\*\*\*\*

#### PANEL DATA REGRESSION ANALYSIS

\*\*\*\*\*

\*\*\*\*\* HQLA HYPOTHESES \*\*\*\*\*

\*\*\*\*\* Delta Total HQLA \*\*\*\*\*

```
Mfull <- DeltaTotalHQLA ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
mfullHQLA <- plm(Mfull, data = paneldata, effect = "individual", model = "within")
summary(mfullHQLA)
```

```
M1 <- DeltaTotalHQLA ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- DeltaTotalHQLA ~
Delta.NSFR+Lagged.NSFR.Deficit+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X20
11Dummy+X2012Dummy+X2013Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- DeltaTotalHQLA ~
Delta.NSFR+Lagged.NSFR.Deficit+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X20
11Dummy+X2012Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```



```

M1 <- DeltaTotalHQLA ~
Delta.NSFR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy+X2012Du
mmy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

Mred <- DeltaTotalHQLA ~
Delta.NSFR+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy+X2012Dummy
mredHQLA <- plm(Mred, data = paneldata, effect = "individual", model = "within")
summary(mredHQLA)

***** Ratio of Total HQLA To Total Assets*****

M1 <- HV42DeltaRatioOfHQLAToTotalLiabilites ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV42DeltaRatioOfHQLAToTotalLiabilites ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Lagged.LR.Deficit+Total.Assets+X2011Dummy
+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV42DeltaRatioOfHQLAToTotalLiabilites ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Lagged.LR.Deficit+Total.Assets+X2011Dummy
+X2012Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV42DeltaRatioOfHQLAToTotalLiabilites ~
Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+Lagged.LR.Deficit+Total.Assets+X2011Dummy+X2012Dummy+X20
14Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV42DeltaRatioOfHQLAToTotalLiabilites ~
Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+Total.Assets+X2011Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV42DeltaRatioOfHQLAToTotalLiabilites ~
Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+X2011Dummy+X2014Dummy
mHQLARatio <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(mHQLARatio)

***** HQLA Cash *****

M1 <- HV1DeltaRatioOfHQLACashToTotalLiabilities ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV1DeltaRatioOfHQLACashToTotalLiabilities ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Total.Assets+X2011Dum
my+X2012Dummy+X2013Dummy+X2014Dummy

```

```
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV1DeltaRatioOfHQLACashToTotalLiabilities ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+X2011Dummy+X2012Du
mmy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV1DeltaRatioOfHQLACashToTotalLiabilities ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+X2011Dummy+X2012Du
mmy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV1DeltaRatioOfHQLACashToTotalLiabilities ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Delta.Leverage.Ratio+X2011Dummy+X2012Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
MCash <- HV1DeltaRatioOfHQLACashToTotalLiabilities ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Delta.Leverage.Ratio+X2011Dummy+X2012Dummy
mCash <- plm(MCash, data = paneldata, effect = "individual", model = "within")
summary(mCash)
```

\*\*\*\*\* HQLA Securities \*\*\*\*\*

```
M1 <- HV2DeltaRatioOfHQLASecuritiesToTotalLiabilites ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV2DeltaRatioOfHQLASecuritiesToTotalLiabilites ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV2DeltaRatioOfHQLASecuritiesToTotalLiabilites ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Total.Assets+X2011Dum
my+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV2DeltaRatioOfHQLASecuritiesToTotalLiabilites ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Total.Assets+X2012Dum
my+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV2DeltaRatioOfHQLASecuritiesToTotalLiabilites ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+X2012Dummy+X2013Du
mmy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV2DeltaRatioOfHQLASecuritiesToTotalLiabilites ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV2DeltaRatioOfHQLASecuritiesToTotalLiabilites ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1Sec <- HV2DeltaRatioOfHQLASecuritiesToTotalLiabilites ~
Delta.NSFR+Lagged.NSFR.Deficit+X2012Dummy+X2013Dummy+X2014Dummy
m1Sec <- plm(M1Sec, data = paneldata, effect = "individual", model = "within")
summary(m1Sec)
```

```
stargazer(mfullHQLA,mredHQLA,mHQLARatio,mCash,m1Sec, type="html",digits = 4, notes = "Method: Panel Data
Regression with Fixed Effects Estimation",
dep.var.labels=c("Delta of Total HQLA", "Delta Ratio of Total HQLA", "Delta Ratio of HQLA Cash", "Delta Ratio of
HQLA Securities"),
covariate.labels=c("Delta NSFR", "Lagged NSFR Deficit", "Delta LCR", "Lagged LCR Deficit", "Delta LR", "Lagged LR
Deficit", "Total Assets",
"2011 Dummy", "2012 Dummy", "2013 Dummy", "2014 Dummy"), out="models.htm")
```

\*\*\*\*\*LENDING HYPOTHESIS\*\*\*\*\*

\*\*\*\*\*Delta Total Loans\*\*\*\*\*

```
M1 <- HV31DeltaTotalLoans ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
mfulltotalloans <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(mfulltotalloans)
```

```
M1 <- HV31DeltaTotalLoans ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2014Dummy
mfull <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(mfull)
```

```
M1 <- HV31DeltaTotalLoans ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy
mfull <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(mfull)
```

```
M1 <- HV31DeltaTotalLoans ~
Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy
+X2012Dummy
mfull <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(mfull)
```

```
M1 <- HV31DeltaTotalLoans ~
Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2012Dummy
mfull <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(mfull)
```

```
M1 <- HV31DeltaTotalLoans ~
Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets
mredtotalloans <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(mredtotalloans)
```

\*\*\*\*\*Ratio Of Total Loans To Total Assets\*\*\*\*\*

```
M1 <- HV43DeltaRatioOfTotalLoansToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV43DeltaRatioOfTotalLoansToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Total.Assets+X2011Dum
my+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV43DeltaRatioOfTotalLoansToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Total.Assets+X2011Dummy+X2012Dummy+X
2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV43DeltaRatioOfTotalLoansToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Total.Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014
Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV43DeltaRatioOfTotalLoansToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV43DeltaRatioOfTotalLoansToTotalAssets ~
Delta.NSFR+Delta.LCR+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
mloanratio <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(mloanratio)
```

\*\*\*\*\*Loans with 0% Risk Weight\*\*\*\*\*

```
M1 <- HV27DeltaRatioOfLoans0RWTToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV27DeltaRatioOfLoans0RWTToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV27DeltaRatioOfLoans0RWTToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV27DeltaRatioOfLoans0RWTToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+X201
1Dummy+X2012Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV27DeltaRatioOfLoans0RWTToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+X2011Dummy+X2012Du
mmy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV27DeltaRatioOfLoans0RWTToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+X2011Dummy+X2012Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV27DeltaRatioOfLoans0RWTToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+X2011Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV27DeltaRatioOfLoans0RWTToTotalAssets ~ Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+X2011Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV27DeltaRatioOfLoans0RWTToTotalAssets ~ Delta.NSFR+Delta.LCR+X2011Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV27DeltaRatioOfLoans0RWTToTotalAssets ~ Delta.NSFR+X2011Dummy
mloan0rw <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(mloan0rw)
```

\*\*\*\*\*Loans with 20% Risk Weight\*\*\*\*\*

```
M1 <- HV28DeltaRatioOfLoans20RWTToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV28DeltaRatioOfLoans20RWTToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X20
11Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV28DeltaRatioOfLoans20RWTToTotalAssets ~
Delta.NSFR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy+X2012Du
mmy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
```

```
summary(m1)
```

```
M1 <- HV28DeltaRatioOfLoans20RWToTotalAssets ~  
Delta.NSFR+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy+X2012Dummy+X2013Dummy+  
X2014Dummy  
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")  
summary(m1)
```

```
M1 <- HV28DeltaRatioOfLoans20RWToTotalAssets ~  
Delta.NSFR+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy+X2012Dummy+X2013Dummy+  
X2014Dummy  
mloan20rw <- plm(M1, data = paneldata, effect = "individual", model = "within")  
summary(mloan20rw)
```

```
*****Loans with 50% Risk Weight*****
```

```
M1 <- HV29DeltaRatioOfLoans50RWToTotalAssets ~  
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.  
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy  
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")  
summary(m1)
```

```
M1 <- HV29DeltaRatioOfLoans50RWToTotalAssets ~  
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.  
Assets+X2011Dummy+X2012Dummy+X2013Dummy  
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")  
summary(m1)
```

```
M1 <- HV29DeltaRatioOfLoans50RWToTotalAssets ~  
Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy  
+X2012Dummy+X2013Dummy  
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")  
summary(m1)
```

```
M1 <- HV29DeltaRatioOfLoans50RWToTotalAssets ~  
Delta.NSFR+Delta.LCR+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X2012Dummy+X2013Dummy  
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")  
summary(m1)
```

```
M1 <- HV29DeltaRatioOfLoans50RWToTotalAssets ~  
Delta.NSFR+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X2012Dummy+X2013Dummy  
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")  
summary(m1)
```

```
M1 <- HV29DeltaRatioOfLoans50RWToTotalAssets ~  
Delta.NSFR+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X2012Dummy  
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")  
summary(m1)
```

```
M1 <- HV29DeltaRatioOfLoans50RWToTotalAssets ~  
Delta.NSFR+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2012Dummy  
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")  
summary(m1)
```

```
M1 <- HV29DeltaRatioOfLoans50RWToTotalAssets ~ Delta.NSFR+Lagged.LR.Deficit+X2012Dummy  
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")  
summary(m1)
```

```
M1 <- HV29DeltaRatioOfLoans50RWToTotalAssets ~ Delta.NSFR+X2012Dummy
mloan50rw <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(mloan50rw)
```

\*\*\*\*\*Ratio of Loans with 100% Risk Weight\*\*\*\*\*

```
M1 <- HV30DeltaRatioOfLoans100RWToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV30DeltaRatioOfLoans100RWToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+X201
1Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV30DeltaRatioOfLoans100RWToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X2012Du
mmy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV30DeltaRatioOfLoans100RWToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2012Dummy+X2013Du
mmy+X2014Dummy
mloan100rw <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(mloan100rw)
```

```
stargazer(mfulltotalloans,mredtotalloans,mloanratio,mloan0rw,mloan20rw,mloan50rw,mloan100rw, type="html",digits
= 4, notes = "Method: Panel Data Regression with Fixed Effects Estimation",
dep.var.labels=c("Delta of Total Loans", "Delta Ratio of Total Loans", "Delta Ratio of Loans 0RW", "Delta Ratio of
Loans 20RW", "Delta Ratio of Loans 50RW", "Delta Ratio of Loans 100RW"),
covariate.labels=c("Delta NSFR", "Lagged NSFR Deficit", "Delta LCR", "Lagged LCR Deficit", "Delta LR", "Lagged LR
Deficit", "Total Assets",
"2011 Dummy", "2012 Dummy", "2013 Dummy", "2014 Dummy"), out="models.htm")
```

\*\*\*\*\*DEPOSIT HYPOTHESIS\*\*\*\*\*

\*\*\*\*\*Delta Total Deposits\*\*\*\*\*

```
Mfulldeposits <- HV32DeltaTotalDeposits ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
mfulldeposits <- plm(Mfulldeposits, data = paneldata, effect = "individual", model = "within")
summary(mfulldeposits)
```

```
M1 <- HV32DeltaTotalDeposits ~
Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy
+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV32DeltaTotalDeposits ~
Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy
+X2013Dummy+X2014Dummy
```

```
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
Mreddeposits <- HV32DeltaTotalDeposits ~
Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy
+X2013Dummy+X2014Dummy
mreddeposits <- plm(Mreddeposits, data = paneldata, effect = "individual", model = "within")
summary(mreddeposits)
```

```
*****Ratio of Total Time Deposits To Total Liabilities*****
```

```
M1 <- HV52DeltaRatioOfTotalDepositstoTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV52DeltaRatioOfTotalDepositstoTotalAssets ~
Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy
+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV52DeltaRatioOfTotalDepositstoTotalAssets ~
Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Total.Assets+X2011Dummy+X2012Dummy+X2
013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
Mratioedeposits <- HV52DeltaRatioOfTotalDepositstoTotalAssets ~
Delta.NSFR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Total.Assets+X2011Dummy+X2012Dummy+X2013Dummy
+X2014Dummy
mratioedeposits <- plm(Mratioedeposits, data = paneldata, effect = "individual", model = "within")
summary(mratioedeposits)
```

```
*****Ratio of Large Time Deposits*****
```

```
M1 <- HV53DeltaRatioOfLongTermLargeTimeDeposits ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV53DeltaRatioOfLongTermLargeTimeDeposits ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+X201
1Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV53DeltaRatioOfLongTermLargeTimeDeposits ~
Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X2012Dum
my+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV53DeltaRatioOfLongTermLargeTimeDeposits ~
Delta.NSFR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X2012Dummy+X2013D
ummy+X2014Dummy
```



```

m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV53DeltaRatioOfLongTermLargeTimeDeposits ~
Delta.NSFR+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dumm
y
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV53DeltaRatioOfLongTermLargeTimeDeposits ~
Delta.NSFR+Delta.Leverage.Ratio+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

MLTLTimeDep <- HV53DeltaRatioOfLongTermLargeTimeDeposits ~
Delta.NSFR+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
mLTLTimeDep <- plm(MLTLTimeDep, data = paneldata, effect = "individual", model = "within")
summary(mLTLTimeDep)

*****Ratio of Short-Term Large Time Deposits*****

M1 <- HV54DeltaRatioOfShortTermLargeTimeDeposits ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV54DeltaRatioOfShortTermLargeTimeDeposits ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV54DeltaRatioOfShortTermLargeTimeDeposits ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2013Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

MSTLTimeDep <- HV54DeltaRatioOfShortTermLargeTimeDeposits ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy
mSTLTimeDep <- plm(MSTLTimeDep, data = paneldata, effect = "individual", model = "within")
summary(mSTLTimeDep)

*****Ratio of Short-Term Small Time Deposits*****

M1 <- HV55DeltaRatioOfShortTermSmallTimeDeposits ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV55DeltaRatioOfShortTermSmallTimeDeposits ~
Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy
+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

```

```
M1 <- HV55DeltaRatioOfShortTermSmallTimeDeposits ~
Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy
+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV55DeltaRatioOfShortTermSmallTimeDeposits ~
Delta.NSFR+Delta.LCR+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy+X2012Dummy+X20
13Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV55DeltaRatioOfShortTermSmallTimeDeposits ~
Delta.NSFR+Delta.LCR+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X2012Dummy+X2013Dummy+X
2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
MSTSTimeDep <- HV55DeltaRatioOfShortTermSmallTimeDeposits ~
Delta.NSFR+Delta.LCR+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2012Dummy+X2013Dummy+X2014Dummy
mSTSTimeDep <- plm(MSTSTimeDep, data = paneldata, effect = "individual", model = "within")
summary(mSTSTimeDep)
```

\*\*\*\*\*Ratio of Transaction Deposits\*\*\*\*\*

```
M1 <- HV56DeltaRatioOfTransactionDeposits ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV56DeltaRatioOfTransactionDeposits ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+X201
1Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV56DeltaRatioOfTransactionDeposits ~
Delta.NSFR+Lagged.NSFR.Deficit+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X
2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV56DeltaRatioOfTransactionDeposits ~
Delta.NSFR+Lagged.NSFR.Deficit+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2012Dummy+X
2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV56DeltaRatioOfTransactionDeposits ~
Delta.NSFR+Lagged.NSFR.Deficit+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2012Dummy+X
2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV56DeltaRatioOfTransactionDeposits ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2012Dummy+X2014Dummy
```

```
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV56DeltaRatioOfTransactionDeposits ~
Delta.NSFR+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2012Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV56DeltaRatioOfTransactionDeposits ~ Delta.NSFR+Lagged.LR.Deficit+X2012Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV56DeltaRatioOfTransactionDeposits ~ Delta.NSFR+X2012Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV56DeltaRatioOfTransactionDeposits ~ Delta.NSFR+X2012Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
MTransDep <- HV56DeltaRatioOfTransactionDeposits ~ Delta.NSFR
mTransDep <- plm(MTransDep, data = paneldata, effect = "individual", model = "within")
summary(mTransDep)
```

\*\*\*\*\*Ratio of Foreign Deposits\*\*\*\*\*

```
M1 <- HV57DeltaRatioOfForeignDeposits ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV57DeltaRatioOfForeignDeposits ~
Delta.NSFR+Lagged.NSFR.Deficit+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X20
11Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV57DeltaRatioOfForeignDeposits ~
Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy
+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV57DeltaRatioOfForeignDeposits ~
Delta.NSFR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy+X2012Du
mmy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV57DeltaRatioOfForeignDeposits ~
Delta.NSFR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X2012Dummy+X2013D
ummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV57DeltaRatioOfForeignDeposits ~
Delta.NSFR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X2012Dummy+X2014D
ummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV57DeltaRatioOfForeignDeposits ~
Delta.NSFR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X2012Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV57DeltaRatioOfForeignDeposits ~
Delta.NSFR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+X2011Dummy+X2012Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV57DeltaRatioOfForeignDeposits ~ Delta.NSFR+Lagged.LCR.Deficit+X2011Dummy+X2012Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV57DeltaRatioOfForeignDeposits ~ Lagged.LCR.Deficit+X2011Dummy+X2012Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV57DeltaRatioOfForeignDeposits ~ Lagged.LCR.Deficit+X2011Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
MForDep <- HV57DeltaRatioOfForeignDeposits ~ Delta.NSFR
mForDep <- plm(MForDep, data = paneldata, effect = "individual", model = "within")
summary(mForDep)
```

\*\*\*\*\*Ratio of Wholesale Deposits\*\*\*\*\*

```
M1 <- HV58DeltaRatioOfWholesaleDeposits ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dumm
y+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV58DeltaRatioOfWholesaleDeposits ~
Delta.NSFR+Delta.LCR+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy+X2012Dummy+X20
13Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV58DeltaRatioOfWholesaleDeposits ~
Delta.NSFR+Delta.LCR+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy+X2013Dummy+X20
14Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV58DeltaRatioOfWholesaleDeposits ~
Delta.NSFR+Delta.LCR+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
MWholeDep <- HV58DeltaRatioOfWholesaleDeposits ~
Delta.NSFR+Delta.LCR+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2013Dummy+X2014Dummy
mWholeDep <- plm(MWholeDep, data = paneldata, effect = "individual", model = "within")
summary(mWholeDep)
```

```
stargazer(mfulldeposits,mreddeposits,mratiodeposits, type="html",digits = 4, notes = "Method: Panel Data Regression
with Fixed Effects Estimation",
dep.var.labels=c("Delta of Total Deposits", "Delta Ratio of Total Deposits To Total Liabilities"),
covariate.labels=c("Delta NSFR","Lagged NSFR Deficit","Delta LCR","Lagged LCR Deficit","Delta LR","Lagged LR
Deficit","Total Assets",
"2011 Dummy","2012 Dummy","2013 Dummy","2014 Dummy"), out="models.htm")
```

```
stargazer(mLTLTimeDep,mSTLTimeDep,mSTSTimeDep,mTransDep,mForDep,mWholeDep, type="html",digits = 4,
notes = "Method: Panel Data Regression with Fixed Effects Estimation",
dep.var.labels=c("Delta Ratio of LT Large Time Dep.", "Delta Ratio of ST Large Time Dep.", "Delta Ratio of ST Small
Time Dep.", "Delta Ratio of Transaction Dep.", "Delta Ratio of Foreign Dep.", "Delta Ratio of Wholesale Dep."),
covariate.labels=c("Delta NSFR","Lagged NSFR Deficit","Delta LCR","Lagged LCR Deficit","Delta LR","Lagged LR
Deficit","Total Assets",
"2011 Dummy","2012 Dummy","2013 Dummy","2014 Dummy"), out="models.htm")
```

\*\*\*\*\* DERIVATIVES HYPOTHESIS \*\*\*\*\*

\*\*\*\*\*Delta Total Derivatives\*\*\*\*\*

```
Mfullderivatives <- HV26DeltaTotalDerivatives ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
mfullderivatives <- plm(Mfullderivatives, data = paneldata, effect = "individual", model = "within")
summary(mfullderivatives)
```

```
M1 <- HV26DeltaTotalDerivatives ~
Delta.NSFR+Lagged.NSFR.Deficit+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X20
11Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV26DeltaTotalDerivatives ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy+X2012Du
mmy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV26DeltaTotalDerivatives ~
Delta.NSFR+Lagged.NSFR.Deficit+Lagged.LR.Deficit+Total.Assets+X2011Dummy+X2012Dummy+X2013Dummy+
X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV26DeltaTotalDerivatives ~
Lagged.NSFR.Deficit+Lagged.LR.Deficit+Total.Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dumm
y
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```

M1 <- HV26DeltaTotalDerivatives ~
Lagged.NSFR.Deficit+Total.Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV26DeltaTotalDerivatives ~
Lagged.NSFR.Deficit+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

Mredderivatives <- HV26DeltaTotalDerivatives ~ X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
mredderivatives <- plm(Mredderivatives, data = paneldata, effect = "individual", model = "within")
summary(mredderivatives)

*****Delta Ratio of Total Derivatives To Total Assets*****

Mfullratio <- HV41DeltaRatioofTotalDerivativesToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
mfullratio <- plm(Mfullratio, data = paneldata, effect = "individual", model = "within")
summary(mfullratio)

M1 <- HV41DeltaRatioofTotalDerivativesToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+X201
1Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV41DeltaRatioofTotalDerivativesToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X2012Du
mmy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "pooling")
summary(m1)

M1 <- HV41DeltaRatioofTotalDerivativesToTotalAssets ~
Delta.NSFR+Delta.LCR+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X2012Dummy+X2013Dummy+X
2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "pooling")
summary(m1)

M1 <- HV41DeltaRatioofTotalDerivativesToTotalAssets ~
Delta.NSFR+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dumm
y
m1 <- plm(M1, data = paneldata, effect = "individual", model = "pooling")
summary(m1)

M1 <- HV41DeltaRatioofTotalDerivativesToTotalAssets ~
Delta.NSFR+Lagged.LR.Deficit+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "pooling")
summary(m1)

Mratioderivatives <- HV41DeltaRatioofTotalDerivativesToTotalAssets ~
Delta.NSFR+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
mratioderivatives <- plm(Mratioderivatives, data = paneldata, effect = "individual", model = "pooling")
summary(mratioderivatives)

stargazer(mfullderivatives,mredderivatives,mratioderivatives, type="html",digits = 4, notes = "Method: Panel Data
Regression with Fixed Effects Estimation",

```

```

dep.var.labels=c("Delta of Total Derivatives", "Delta Ratio of Total Derivatives To Total Assets"),
covariate.labels=c("Delta NSFR", "Lagged NSFR Deficit", "Delta LCR", "Lagged LCR Deficit", "Delta LR", "Lagged LR
Deficit", "Total Assets",
"2011 Dummy", "2012 Dummy", "2013 Dummy", "2014 Dummy"), out="models.htm")

```

\*\*\*\*\* SECURITIES HYPOTHESIS \*\*\*\*\*

\*\*\*\*\*Delta Total Securities\*\*\*\*\*

```

Msecuritiesfull <- HV51DeltaTotalSecurities ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
msecuritiesfull <- plm(Msecuritiesfull, data = paneldata, effect = "individual", model = "within")
summary(msecuritiesfull)

```

```

M1 <- HV51DeltaTotalSecurities ~
Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy
+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

```

```

M1 <- HV51DeltaTotalSecurities ~
Delta.NSFR+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy
+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

```

```

M1 <- HV51DeltaTotalSecurities ~
Delta.NSFR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy+X2013Du
mmy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

```

```

M1 <- HV51DeltaTotalSecurities ~
Delta.NSFR+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

```

```

M1 <- HV51DeltaTotalSecurities ~
Delta.NSFR+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy+X2013Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

```

```

M1 <- HV51DeltaTotalSecurities ~
Delta.NSFR+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X2013Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

```

```

M1 <- HV51DeltaTotalSecurities ~ Delta.NSFR+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2013Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

```

```

Msecuritiesred <- HV51DeltaTotalSecurities ~ Delta.NSFR+Delta.Leverage.Ratio+Lagged.LR.Deficit
msecuritiesred <- plm(Msecuritiesred, data = paneldata, effect = "individual", model = "within")
summary(msecuritiesred)

```

\*\*\*\*\*Delta Ratio of Total Securities To Total Assets\*\*\*\*\*

```
M1 <- HV45DeltaRatioOfTotalSecuritiesToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV45DeltaRatioOfTotalSecuritiesToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Total.Assets+X2011Dum
my+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV45DeltaRatioOfTotalSecuritiesToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Total.Assets+X2012Dum
my+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV45DeltaRatioOfTotalSecuritiesToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Delta.Leverage.Ratio+Total.Assets+X2012Dummy+X2013Dummy+
X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV45DeltaRatioOfTotalSecuritiesToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Delta.Leverage.Ratio+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV45DeltaRatioOfTotalSecuritiesToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.Leverage.Ratio+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
Mratiosec <- HV45DeltaRatioOfTotalSecuritiesToTotalAssets ~
Delta.NSFR+Lagged.NSFR.Deficit+X2012Dummy+X2013Dummy+X2014Dummy
mratiosec <- plm(Mratiosec, data = paneldata, effect = "individual", model = "within")
summary(mratiosec)
```

\*\*\*\*\*Delta Ratio of Total Securities 0RW To Total Assets\*\*\*\*\*

```
M1 <- HV37DeltaRatioOfSecuritiesToTotalAssets0RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV37DeltaRatioOfSecuritiesToTotalAssets0RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dum
my+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV37DeltaRatioOfSecuritiesToTotalAssets0RW ~
Delta.NSFR+Delta.LCR+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy+X2012Dummy+X20
13Dummy+X2014Dummy
```



```

m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV37DeltaRatioOfSecuritiesToTotalAssets0RW ~
Delta.LCR+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.Assets+X2011Dummy+X2012Dummy+X2013Dummy+X
2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV37DeltaRatioOfSecuritiesToTotalAssets0RW ~
Delta.LCR+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV37DeltaRatioOfSecuritiesToTotalAssets0RW ~
Delta.LCR+Delta.Leverage.Ratio+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

Msec0rw <- HV37DeltaRatioOfSecuritiesToTotalAssets0RW ~
Delta.LCR+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
msec0rw <- plm(Msec0rw, data = paneldata, effect = "individual", model = "within")
summary(msec0rw)

*****Delta Ratio of Total Securities 20RW To Total Assets*****

M1 <- HV38DeltaRatioOfSecuritiesToTotalAssets20RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV38DeltaRatioOfSecuritiesToTotalAssets20RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+X201
1Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV38DeltaRatioOfSecuritiesToTotalAssets20RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+X201
1Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV38DeltaRatioOfSecuritiesToTotalAssets20RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+X2011Dummy+X
2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV38DeltaRatioOfSecuritiesToTotalAssets20RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Lagged.LCR.Deficit+Lagged.LR.Deficit+X2011Dummy+X2013Dummy+X2014
Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)

M1 <- HV38DeltaRatioOfSecuritiesToTotalAssets20RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Lagged.LR.Deficit+X2011Dummy+X2013Dummy+X2014Dummy

```

```
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV38DeltaRatioOfSecuritiesToTotalAssets20RW ~
Delta.NSFR+Lagged.NSFR.Deficit+X2011Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV38DeltaRatioOfSecuritiesToTotalAssets20RW ~
Delta.NSFR+Lagged.NSFR.Deficit+X2011Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
Msec20rw <- HV38DeltaRatioOfSecuritiesToTotalAssets20RW ~ Delta.NSFR+X2011Dummy+X2014Dummy
msec20rw <- plm(Msec20rw, data = paneldata, effect = "individual", model = "within")
summary(msec20rw)
```

\*\*\*\*\*Delta Ratio of Total Securities 50RW To Total Assets\*\*\*\*\*

```
Mratiofull <- HV39DeltaRatioOfSecuritiesToTotalAssets50RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
mratiofull <- plm(Mratiofull, data = paneldata, effect = "individual", model = "within")
summary(mratiofull)
```

```
M1 <- HV39DeltaRatioOfSecuritiesToTotalAssets50RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV39DeltaRatioOfSecuritiesToTotalAssets50RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV39DeltaRatioOfSecuritiesToTotalAssets50RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV39DeltaRatioOfSecuritiesToTotalAssets50RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Lagged.LR.Deficit+Total.Assets+X2011Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV39DeltaRatioOfSecuritiesToTotalAssets50RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Total.Assets+X2011Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV39DeltaRatioOfSecuritiesToTotalAssets50RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Total.Assets+X2011Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV39DeltaRatioOfSecuritiesToTotalAssets50RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Total.Assets+X2011Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV39DeltaRatioOfSecuritiesToTotalAssets50RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Total.Assets+X2011Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV39DeltaRatioOfSecuritiesToTotalAssets50RW ~ Delta.NSFR+Lagged.NSFR.Deficit+X2011Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
Msec50rw <- HV39DeltaRatioOfSecuritiesToTotalAssets50RW ~ Delta.NSFR+Lagged.NSFR.Deficit
msec50rw <- plm(Msec50rw, data = paneldata, effect = "individual", model = "within")
summary(msec50rw)
```

\*\*\*\*\*Delta Ratio of Total Securities 100RW To Total Assets\*\*\*\*\*

```
M1 <- HV40DeltaRatioOfSecuritiesToTotalAssets100RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV40DeltaRatioOfSecuritiesToTotalAssets100RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Total.Assets+X2011Dum
my+X2012Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV40DeltaRatioOfSecuritiesToTotalAssets100RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Total.Assets+X2011Dummy+X2012Dummy+X
2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV40DeltaRatioOfSecuritiesToTotalAssets100RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+X2011Dummy+X2012Dummy+X2013Dummy
+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV40DeltaRatioOfSecuritiesToTotalAssets100RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Lagged.LCR.Deficit+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dum
my
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV40DeltaRatioOfSecuritiesToTotalAssets100RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Lagged.LCR.Deficit+X2011Dummy+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
M1 <- HV40DeltaRatioOfSecuritiesToTotalAssets100RW ~
Delta.NSFR+Lagged.NSFR.Deficit+Lagged.LCR.Deficit+X2013Dummy+X2014Dummy
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
```

```
summary(m1)
```

```
M1 <- HV40DeltaRatioOfSecuritiesToTotalAssets100RW ~  
Delta.NSFR+Lagged.NSFR.Deficit+X2013Dummy+X2014Dummy  
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")  
summary(m1)
```

```
Msec100rw <- HV40DeltaRatioOfSecuritiesToTotalAssets100RW ~  
Delta.NSFR+Lagged.NSFR.Deficit+X2014Dummy  
msec100rw <- plm(Msec100rw, data = paneldata, effect = "individual", model = "within")  
summary(msec100rw)
```

```
stargazer(msecuritiesfull,msecuritiesred,mratiosec, type="html",digits = 4, notes = "Method: Panel Data Regression  
with Fixed Effects Estimation",  
dep.var.labels=c("Delta of Total Securities", "Delta Ratio of Securities To Total Assets"),  
covariate.labels=c("Delta NSFR", "Lagged NSFR Deficit", "Delta LCR", "Lagged LCR Deficit", "Delta LR", "Lagged LR  
Deficit", "Total Assets",  
"2011 Dummy", "2012 Dummy", "2013 Dummy", "2014 Dummy"), out="models.htm")
```

```
stargazer(mratiofull, msec0rw,msec20rw,msec50rw,msec100rw, type="html",digits = 4, notes = "Method: Panel Data  
Regression with Fixed Effects Estimation",  
dep.var.labels=c("Delta Ratio of Total Securities", "Delta Ratio of 0RW Securities", "Delta Ratio of 20RW  
Securities", "Delta Ratio of 50RW Securities", "Delta Ratio of 100RW Securities"),  
covariate.labels=c("Delta NSFR", "Lagged NSFR Deficit", "Delta LCR", "Lagged LCR Deficit", "Delta LR", "Lagged LR  
Deficit", "Total Assets",  
"2011 Dummy", "2012 Dummy", "2013 Dummy", "2014 Dummy"), out="models.htm")
```

```
stargazer(msecuritiesfull,msecuritiesred,mratiosec,msec0rw,msec20rw,msec50rw,msec100rw, type="html",digits = 4,  
notes = "Method: Panel Data Regression with Fixed Effects Estimation",  
dep.var.labels=c("Delta of Total Securities", "Delta Ratio of Securities To Total Assets", "Delta Ratio of 0RW  
Securities", "Delta Ratio of 20RW Securities", "Delta Ratio of 50RW Securities", "Delta Ratio of 100RW Securities"),  
covariate.labels=c("Delta NSFR", "Lagged NSFR Deficit", "Delta LCR", "Lagged LCR Deficit", "Delta LR", "Lagged LR  
Deficit", "Total Assets",  
"2011 Dummy", "2012 Dummy", "2013 Dummy", "2014 Dummy"), out="models.htm")
```

```
*****  
MODEL REDUCTION TESTS  
*****
```

```
M1 <- HV31DeltaTotalLoans ~  
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.  
Assets+X2011Dummy+X2012Dummy+X2013Dummy+X2014Dummy  
mtimefull <- lm(M1, data = paneldata)  
summary(mtimefull)
```

```
M1 <- HV31DeltaTotalLoans ~  
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.  
Assets  
mtimereduced <- lm(M1, data = paneldata)  
summary(mtimereduced)
```

```
anova(mtimereduced,mtimefull)
```

```
M1 <- HV31DeltaTotalLoans ~  
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.  
Assets+GDP.2009.Chained+CPI+Risk.Free.Rate
```

```
mmacrofull <- lm(M1, data = paneldata)
summary(mmacrofull)

M1 <- HV31DeltaTotalLoans ~
Delta.NSFR+Lagged.NSFR.Deficit+Delta.LCR+Lagged.LCR.Deficit+Delta.Leverage.Ratio+Lagged.LR.Deficit+Total.
Assets
mmacroreduced <- lm(M1, data = paneldata)
summary(mmacroreduced)

anova(mmacroreduced,mmacrofull)

anova(mtimefull,mmacrofull)
```

#### HAUSMAN TESTS FOR ESTIMATOR CHOICE

\*\*\*\*\* Example Test for the Securities Hypothesis \*\*\*\*\*

```
M1 <- HV51DeltaTotalSecurities ~ Delta.NSFR+Delta.Leverage.Ratio+Lagged.LR.Deficit
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
FEmodel <- plm(M1, data = paneldata, effect = "individual", model = "within")
REmodel <- plm(M1, data = paneldata, effect = "individual", model = "random")
phtest(FEmodel, REmodel)
```

#### SERIAL CORRELATION TESTS

\*\*\*\*\* Example Test for the Securities Hypothesis \*\*\*\*\*

```
M1 <- HV51DeltaTotalSecurities ~ Delta.NSFR+Delta.Leverage.Ratio+Lagged.LR.Deficit
m1 <- plm(M1, data = paneldata, effect = "individual", model = "within")
summary(m1)
```

```
pbgtest(m1, order=1)
pbgtest(m1, order=2)
pbgtest(m1, order=3)
```

```
acf(m1$residuals, main="ACF for Residuals from the Total Securites Model")
```

#### PRINCIPAL COMPONENT ANALYSIS

```
PCAMatrix <- datafile[-c(1:22)]
VariablesPCA <- as.vector(colnames(PCAMatrix))
VariablesPCA
```

```
PCA <- princomp(PCAMatrix)
summary(PCA)
PCA$sdev
```

\*\*\*\*\*

## PANEL DATA REGRESSION

\*\*\*\*\*

```
* Fixed Effects, FE = "within"
* Random Effects, RE = "random"
* First Differencing, FD = "fd"
* Pooled OLS, Pooling = "pooling"
```

\* Pooled OLS Regression

```
panel.model.pooling <- plm(ModelRed, data = paneldata, effect = "individual", model = "pooling")
summary(panel.model.pooling)
summary(residuals(panel.model.pooling))
panel.model.pooling$formula
```

\* Fixed Effects Regression

```
panel.model.FE <- plm(ModelRed2, data = paneldata, effect = "individual", model = "within")
summary(panel.model.FE)
```

\* Random Effects Regression

```
panel.model.RE <- plm(Model, data = paneldata, effect = "individual", model = "random")
summary(panel.model.RE)
```

\* First Difference Regression

```
panel.model.FD <- plm(Model, data = paneldata, effect = "individual", model = "fd")
summary(panel.model.FD)
```

\*\*\*\*\*

## ADDITIONAL TESTS

\*\*\*\*\*

\* Individual vs. Time Effects in a within (Fixed Effects) Model

```
Model <- as.formula(paste('Delta.NSFR ~', paste(colnames(paneldata)[13:94], collapse='+')))
Model
panel.model.pooling <- plm(Model, data = paneldata, effect = "individual", model = "pooling")
```

```
zTime <- plm(Model, data = paneldata, effect="time", model="within")
zTwoways <- plm(Model, data = paneldata, effect="twoways", model="within")
zIndividual <- plm(Model, data = paneldata, model="pooling")
pFtest(zTime,zIndividual)
pFtest(zTwoways,zIndividual)
```

```
* Pooling Test - Testing whether poolability is appropriate
* Testing whether the same set of coefficients apply to each individual
* F-test comparing two different models: Fixed to Pooling
```

```
znpc <- pvcmm(Model, data = paneldata, effect = "individual", model = "within")
zplm <- plm(Model, data = paneldata, effect = "individual")
pooltest(zplm, znpc)
```

or

```
pooltest(inv~value+capital, data = paneldata, effect = "individual", model = "within")
```

- \* Hausmann Test - Determining whether Fixed or Random Effects is most appropriate
- \* Compares two sets of estimates
- \* F-test comparing two different models: Fixed Effects to Random Effects

```
zwithin <- plm(M1, data = paneldata, effect = "individual", model = "within")  
zrandom <- plm(M1, data = paneldata, effect = "individual", model = "random")  
phtest(zwithin, zrandom)  
phtest(panel.model.FE, panel.model.RE)
```

- \* Serial Correlation Test - Testing for AR(1) dependency in idiosyncratic errors

```
pbgtest(panel.model.pooling, order=2)  
pbgtest(panel.model.FE, order=2)  
pbgtest(panel.model.pooling, order=2)
```