Does the implementation of a Net Stable Funding Ratio enhance the financial stability of the banking industry? An international study

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Abstract

During the recent financial crisis (2007-2009) banks suffered huge financial and reputational consequences as a result of excessive risk taking, complicated securitization, and an asset-liability mismatch. To address this situation the Basel Committee on Banking Supervision (BCBS) introduced an updated capital regulatory framework called Basel III which included the requirement for banks to maintain a Net Stable Funding Ratio (NSFR). This paper investigates the effectiveness of Basel III by linking the NSFR with overall financial stability. After analyzing annual financial data from 948 banks from 85 countries we found convincing evidence to suggest that NSFR does increase the financial stability of banks.

Key Words: Basel III, Net Stable Funding Ratio, Finance Stability, Illiquidity.

1. Introduction

As noted by Schooner and Taylor (2010) the banking industry provides long-term lending products while simultaneously guaranteeing the liquidity of their liabilities to short-term depositors. However, the recent global financial crisis (2007-2009) saw banks exposed in terms of their funding instability and illiquidity due to the maturity mismatch of assets and liabilities. Banks and other financial intermediaries experienced this situation because they incurred major losses on investments in the US sub-prime mortgage market with the most vulnerable banks requiring State support for survival. Indeed the situation was so dire that a fundamental reassessment of the banking industry and its existing regulatory framework was conducted (Rosenthal, 2011).

In December 2010, the Basel Committee on Banking Supervision (BCBS) announced a package of new regulations under the Basel III accord to address the illiquidity and funding instability issues revealed during the 2007-2009 global financial crisis. Two of the new regulatory requirements were for banks to meet a pre-determined Liquidity Coverage Ratio (LCR) and a Net Stable Funding Ratio (NSFR). The LCR is designed to ensure that banks maintain sufficient liquidity to survive for at least thirty days under stress conditions while the NSFR is designed to avoid the maturity mismatch of assets and liabilities in order to promote a more stable funding environment in the long run.

The introduction of these new regulatory requirements by the BCBS provides a new area of research both for academic and industry researchers. Studies already conducted on the implications of Basel III include: the relationship between capital stability, risk taking behavior

and ownership structure (Jiraporn et al., 2014), bank liquidity (Distinguin et al., 2013), bank net interest margins (King, 2013), and a cost-benefit analysis of the Basel III accord (Dietrich, Hess & Wanzenried, 2014; Yan, Hall & Turner, 2012). However, the impact of Basel III on the financial stability of banks from less sophisticated banking sectors is unexplored. Banks from many less developed countries have limited access to sophisticated financial risk-management tools such as financial derivatives and may rely on traditional risk-management tools for fund management. This paper attempts to fill this gap by providing empirical evidence from a sample of banks after excluding banks from North America and Europe.

Banks are multi-product, multi-factor, profit-maximizing economic units in which decisions concerning output, pricing and the use of inputs are taken simultaneously (Graddy & Kyle, 1979; Ashraf & Goddard, 2012). In this study, the relationship between the required level of financial stability and the maintenance of a sufficient funding reserve is examined in a two-step generalized method of moments (GMM) model. This model allows for simultaneous adjustment of NSFR and stability.

By using a sample of 948 banks from 85 countries (excluding banks from North America and Europe) from 2003 to 2013, we found a positive and statistically significant relationship between the NSFR and Z-score as a proxy for financial stability of banks. Among other bank-specific covariates that contributed positively to the financial stability of banks are the regulatory capital ratio and operating profit. Interestingly, we did not find any impact of engagement in non-traditional banking activities or in higher impairment charges on the stability of banks. However, we did find statistically significant evidence that inflation and higher concentration

within the banking sector negatively affects the stability of banks. The empirical results support the implementation of the Basel III accord.

This paper provides empirical evidence on the association between the NSFR measures introduced in the Basel III accord and the financial stability of the banking sector. Secondly, banks from less developed financial markets usually have less access to income sources outside traditional intermediation activities therefore the NSFR requirements may have stronger implications for these banks. To the best of the authors' knowledge there is no published study that has explored the financial implications of Basel III on banks from less developed markets. This empirical work fills this gap by using data from less sophisticated banks from outside the North American or European banking sectors[1]. This study uses data from pre and post crisis time periods thereby providing a stress test scenario for Basel III.

The organization of the paper is as follows. Section two provides a review of the existing literature that surrounds the new BASEL III accord and the null hypothesis that is the basis of this study. Section three provides an explanation of the suggested impact that the new NSFR requirements will have on the financial stability of the banking industry. Section four provides a detailed description of the variables that affect our analysis of the new NSFR requirements including stability measures, bank-specific and country-specific variables. Section five describes the sample used for this study, the sources of data used, and their analysis. Section six details the empirical methodology that underpins and supports this study followed by a discussion of the results of this study. The final section summarizes the key findings of this study and provides concluding comments.

[1] See Yan et al., (2012) and Dietrich et al., (2014).

2. Literature Review

The BCBS proposed the first capital accord, referred to as Basel I, in 1988. The major focus of the Basel I accord was to adequately capitalize international banks against credit risk. The accord set a required 'minimum' percentage of risk-weighted assets to total bank capital (Santos, 2001). The accord was revised in 1997 to incorporate market risk such as interest rate and foreign exchange risk in the calculation of risk-weighted assets and capital requirements.

In 2004 the BCBS introducing a new capital accord, known as Basel II, to help protect the banking system against a wider range of risks and in response to the increased pace of financial innovations sweeping the banking industry worldwide. The calculation of minimum capital requirements were now to be structured around three pillars: credit risk, market risk and operational risk. Banks were given more autonomy for the assignment of risk-weighting to assets based on expert systems. Unfortunately the Basel II accord did not prevent nor provide a warning of the impending global 2007-2009 financial crisis.

One of the major criticisms of the Basel II accord was its narrow focus on bank-level stability through micro-prudential regulations and was not designed to address systemic issues. This situation gave rise to the ‘too-big-to-fail’ phenomena arising from a moral hazard problem in the banking industry (Schwerter, 2011). Indeed as research by Ashraf and Goddard (2012) reveals, the financial innovations intended to transfer risk from the banking sector to a wider set of investors through capital markets led to the liquidity crunch within the global financial system.

The global financial crisis of 2007-2009 exposed the limitations of the Basel II accord which resulted in a need to reassess the existing banking regulatory framework. This reassessment revealed severe shortcomings in the regulatory framework of the banking industry and resulted in a new framework being introduced. This new framework is known as the Basel III accord.

Several new measures are introduced in the Basel III accord in an effort to avoid a repeat of the liquidity crisis of 2007-2009 (Pakravan, 2014). One of the most important measures to be introduced was the requirements of a NSFR whereby banks are required to maintain sufficient liquid funds should a situation similar to the financial crisis of 2007-2009 arise.

Proponents of Basel III, such as Yan et al., (2012), claim that the adoption of the new regulatory framework helps enhance better risk-management by reducing the frequency of crisis's (loss prevention) and thus decreases economic losses. Likewise, Schwerter (2011) argues that the Basel III accord provides for more effective regulations to achieve the goal of guiding financial institutions (specifically) and the financial system (generally) towards greater stability. Allen et al., (2012) suggests that the adoption of Basel III is a major structural shift in the risk management practices of the banking industry and has the potential to transform business models, processes and governance of international banks.

But the Basel III accord is not without its critics. Admati et al., (2011) claims that the adoption of Basel III will limit credit availability and thus reduce economic activity. Allen et al., (2012) concurs suggesting that the requirements under the Basel III accord results in structural adjustments that might affect the supply of credit in the economy. Pakravan (2014) suggests that

as the Basel III framework is a complex system of ratio calculations and approaches to gauge parameters of riskiness and as such will make it vulnerable to regulatory arbitrage. He further argued that the Basel III accord is a sequel to the two previous accords with similar expected results of not being able to alert regulators before the onset of a major crisis.

In the empirical literature Distinguin et al., (2013) explored the possible linkage between regulatory capital adjustments in response to liquidity constraints by using a sample of 781 US and European banks from 2000 to 2006. They found that U.S. and European banks tend to decrease their regulatory capital ratio when faced with higher illiquidity as defined in the Basel III accord. Similarly, Hong et al., (2014) investigated the impact of liquidity risk measures using the NSFR and liquidity coverage ratios with bank failure using a hazard model on quarterly panel data extracted from the call report data of US banks for the period 2001 to 2011. Their empirical findings suggest that liquidity risk is a predictor of bank failure and to avoid such failures liquidity risk should be minimized not just on an individual bank level but at a system level as well. These findings support new liquidity requirements under the Basel III accord through which banks are now required to maintain and improve their solvency (NSFR) during periods of higher illiquidity.

Yan et al., (2012) investigated the impact of tighter capital regulations and liquidity requirements under the Basel III accord on a sample of 11 UK banks for the period 1997 to 2010. They found that higher regulatory capital requirements not only reduces the probability of a banking crisis but also reduces the economic loss from a banking crisis.

From an international perspective King (2013) studied the impact of the new NSFR requirement on earning ability of banks by using a sample of banks from 15 countries. He found that banks from 10 out of the 15 countries could not meet the minimum NSFR requirements at the end of year 2009. He suggested that a possible response from the banking sector may include shrinkage of the balance sheet, change in the composition of assets (loans or investments) or their maturity with each option having a cost to the wider economy. Jiraporn et al., (2014) studied the relationship between the NSFR and risk-taking behavior of banks by using a sample of 68 banks from 11 East Asian countries for the period 2005-2009. They found an inverse relationship between the intensity of capital regulation and risk-taking by banks using Z-score as a proxy for risk-taking. More precisely they report that an enhancement in capital stability by one standard deviation diminishes risk-taking by 5.37%.

While the empirical literature on developed markets highlight the general benefits of the new regulatory ratio of net stable funding for risk-management the impact of the new NSFR on the financial stability of banks from outside the North American or European banking sectors is unknown. Banks from the omitted regions can be quite different from that of North American and European domiciled banks. These banks may have less access to sophisticated financial risk-management tools such as financial derivatives and may rely on traditional asset-liability matching for fund management. To take this into account our null hypothesis for this study is as follows:

H_0: the NSFR requirements in the Basel III accord will have no impact on the financial stability of banks.

In the event of rejection of the null hypothesis, the sign of the coefficient will determine the cost or benefit of the NSFR on the stability of banks. In the following section we develop the covariates for the empirical estimations.

3. The impact of the NSFR on financial stability

The existing empirical literature has generally focused on developed markets with the resulting research findings highlighting the general benefits of the new regulatory requirements for risk-management implying that the NSFR does helps encourage stability in the banking sector. However, it should be noted that financially stable banks tend to maintain higher funding levels in order to manage a bank-run situation. Furthermore, maintenance of desired stability levels and target NSFR's are not independent decisions.

Research by Ashraf and Goddard (2012) and Distinguin et al., (2013) has shown that decisions made by a bank regarding regulation and risk-management are taken simultaneously. Since the stability level and target NSFR are endogenous to each other, we consider a simultaneous equation system for empirical estimation as below:

$$NSFR_{it} = a_0 + a_1 \widetilde{STBL}_{it} + \sum_{i=1}^{N} a_i X_{it} + \widetilde{E}_{jt} \qquad (1)$$

$$STBL_{it} = \beta_0 + \gamma STBL_{it-1} + \beta_1 \widetilde{NSFR}_{it} + \sum_{i=2}^{N} \beta_i Y_{it} + \lambda_t + \widetilde{\varepsilon}_{it} \qquad (1a)$$

$NSFR_{it}$ is the net stable funding ratio calculated using the Basel III framework, and $STBL_{it}$ is the measure of financial stability for bank i at time t. The discretionary NSFR in equation (1) depends on the true value of stability ($\widetilde{STBL}_{it}$) which is not observable. However, the observed

level of stability ($STBL_{it}$) in equation (1a) of a bank is determined by an endogenously determined adjustment in the net stable funding ratio ($\widetilde{NSFR}_{it}$). Vector *X* and *Y* are observable bank and country-specific control variables to explain variation in the NSFR and stability with possible common variables. λ_t are the (unobserved) individual and time-specific effects that reflect the panel nature of the data. $\widetilde{E}_{it}$ and $\widetilde{\varepsilon}_{it}$ are the error (idiosyncratic) terms that vary over time and between banks.

4. Definition of variables

4.1. Net Stable Funding Ratio

The objective for the development of the Net Stable Funding Ratio (NSFR) is to enhance the long-term resilience of banks through higher availability of liquidity in times of crisis. The NSFR requirements stipulate that banks are to maintain stable funding in relation to the composition of their assets, liabilities and off-balance sheet activities. The ratio representing available stable funding to the required stable funding is written as:

$$NSFR_{it} = \frac{ASF_{it}}{RSF_{it}} \qquad (2)$$

There are two issues when calculating the NSFR. First, there are ambiguities in the guidelines of the Basel III accord which requires the use of judgment. Second, there are format and detail-related gaps in the publically available data that are required for the calculation of the NSFR (Hong et al., 2014). Following the work of King (2013) we made several assumptions related to stable and less-stable categorization of deposits and maturities of liabilities and assets. Below is the set of variables that we have to compute ASF_{it} and RSF_{it} with a brief description of each variable.

Available Stable Funding (ASF)

tregca	Total regulatory capital	*rdyq*	Retail deposits 3 - 12 months
rdb5y	Retail deposits 1 - 5 years	*cdc*	Customer deposits – current
rd5y	Retail deposits > 5 years	*cds*	Customer deposits – savings
Rdq	Retail deposits < 3 months		

Required Stable Funding (RSF)

rml	Residential mortgage loans	*grts*	Guarantees
oml	Ordinary mortgage loans	*aobs*	Acceptances and documentary
ocrl	Other consumer retail loans	*clins*	Committed credit lines
ccl	Corporate & commercial loans	*ocgl*	Other contingent liabilities
ol	Other loans	*ae*	Trading assets – equities
mobs	Managed securitized assets reported off B/S	*tacomd*	Trading assets – commodities
oxp	Other off-balance sheet exposure	*toh*	Trading assets – others

Following the calculation methodology of King (2013), we calculated the NSFR using the following equation:

$$NSFR_{it} = \frac{\begin{array}{l}[(tregcap_{it}) + \{(rdb5y_{it} + rd5y_{it}) \times 0.95\} + \{(rdq_{it} + rdyq_{it}) \times 0.90\} + \\ \{(cdc_{it} + cds_{it}) \times 0.50\}]\end{array}}{\begin{array}{l}[\{(rml_{it} + oml_{it}) \times 0.50\} + \{(ocrl_{it} + ccl_{it} + ol_{it}) \times 0.85 + \\ \{(mobs_{it} + oxp_{it} + clins_{it} + ocgl_{it}) \times 0.05\} + \{(ae_{it} + tacomd_{it} + toh_{it}) \times 0.65\}]\end{array}} \quad (3)$$

The higher ratio of $NSFR_{it}$ implies a better funding situation hence we expect a positive correlation of $NSFR_{it}$ with the stability of banks.

4.2 Stability Measure

Most of the empirical literature on financial stability of banks used Z-score as a tool for the assessment of individual bank insolvency risk and financial stability[2]. Mathematically it measures the number of standard deviations of a bank's return-on-assets it would have to fall to

[2] See for example Boyd and Runkle (1993), De Nicoló (2000), Stiroh (2004), Stiroh and Rumble (2006), Laeven and Levine (2009), Demirgüç-Kunt and Huizinga, (2010), Barrel et al., (2010), and De Haan and Poghosyan (2012).

deplete the sum of its equity and income. Z-score has advantages over other accounting-based financial stability measures such as non-performing loans or loan charge-offs as a proxy for the financial stability of a bank due to its capability to capture both interest and fee-based income streams. Following Lepetit and Strobel (2013)[3], Z-score is calculated as:

$$STBL_{it} = \frac{E(ROA)_i + CAR_{it}}{\sigma(ROA)_i} \quad (4)$$

E(ROA) is the expected return on bank assets, *CAR* is equity capital to asset ratio and *σ(ROA)* is the volatility of return-on-assets, subscript *i* and *t* refers to bank and time respectively. Z-Score is directly related to a bank's instability hence the inverse of Z-score is the bank's level of stability. As it is widely argued in the literature that Z-score is highly skewed we used its log transformation in all empirical estimations (Laeven & Levine, 2009; Schaeck & Cihak, 2012).

4.3 Other control variables influencing the stability of banks and stable funding adjustments, and covariate definitions

Existing empirical literature provides a number of explanations as to why banks may adjust their portfolio risk to meet regulatory requirements. The explanatory variables are divided into two broad categories of bank-specific and industry-specific covariates. In this section, the rationale for each covariate included in the empirical model is considered in detail.

4.3.1 Bank specific variables

Among bank specific variables, the size of the bank significantly influences the composition of assets and the risk-taking behavior of the bank. Demsetz and Strahan (1997) found that larger

[3] Lepetit and Strobel (2013) compared various methods used for calculating Z-score and suggested that an alternative measure that uses mean and standard deviation of the return-on-assets calculated over the full sample period and current values of the CAR ratio is more robust.

banks enjoy better franchise value and are able to use diversification as a tool for risk management. In addition, Schwerter (2011) suggests that the 'too big to fail' phenomenon provides an incentive to larger banks to engage in excessive risk-taking. Larger banks capitalize on implicit or explicit deposit insurance and are prepared to invest in riskier projects to earn risk premiums. Distinguin et al., (2013) concurs finding that larger banks can maintain higher liquidity levels due to easier access to the 'lender of last resort' and would be the first to benefit from this safety net. However, Hakenes and Schnabel (2011) concluded that larger banks have the ability to absorb higher fixed costs and thus can maintain lower capital levels. This additional capital favors larger banks that can afford to offer higher interest rate on deposits.

Due to the 'too big to fail' phenomena, higher franchise value, better risk-management systems and easy access to the 'lender of last resort', we anticipate a positive relationship between the size of banks and their stability. We measure $SIZE_{it}$ as the natural log of total assets.

Cebenoyan and Strahan (2004) and Shrieves and Dahl (1992) found strong empirical evidence to suggest that risk-adverse banks avoid excessive risk-taking and, as such, their portfolios contain lower levels of non-performing loans. De Nicoló et al., (2003), Fofack (2005), Blasco and Sinkey (2006) and Männasoo and Mayes (2009) found that high levels of non-performing loans is positively correlated with the instability of a bank suggesting that a higher level of non-performing loans are a sign of insolvency. We used the ratio of loan impairment charges to gross loans (NPL_{it}) as a proxy for the loan portfolio quality. A higher value of this ratio would indicate a possible deterioration in the stability of banks[4]. We expect that the negative impact of higher loan impairment charge-offs will affect stability. To account for this we used a lag of the NPL_{it}

[4] We did not use the provision for loan losses or loan loss reserves due to management discretion on each item.

in our empirical estimations. We expect a negative coefficient of NPL_{it-1} with Z-score as a measure of stability.

A bank's stability is also a function of its income sources. Banks with more diversified income streams can be stable in times of stress hence it can add to the stability of the bank. Busch and Kick (2009) found that banks enjoy stability benefits with fee income as this type of income is more stable when compared to interest income. We control the impact of income diversification by taking a ratio of non-interest income to gross revenue. We anticipate a positive coefficient for diversification with stability.

Bank profitability is one of the most important drivers of a bank's stability. Financial institutions with strong operational profitability enjoy stable income streams. Drawing on the existing literature (King, 2013; Jiraporn et al., 2014; Hong, 2014), we used operating profit as a ratio of total equity as our measure of profitability. We anticipate a positive sign of profitability with bank stability.

Research by Barrell et al., (2009), Miles et al., (2011) and Caggiano and Calice (2011) suggest that capital adequacy regulations are frequently viewed as a buffer against insolvency crises, limit the costs of financial distress, and reduce the probability of default. However, research by Agoraki et al., (2011) and Bolt and Tieman (2004) concluded that stringent capital requirements come at a cost. If higher capital requirements are imposed, competitive pressures will constrain banks to some extent resulting in competition for loans, deposits and even the sources of equity and debt investments. This competition will lead to higher costs of doing business resulting in

instability. Based on the above argument we anticipate positive (negative) coefficient of regulatory capital with the stability of banks. We employ the ratio of total regulatory capital to risk-weighted assets as a proxy for regulatory capital.

4.3.2 Country-specific control variables

The economic outlook of a country can greatly impact the stability of its financial institutions. Empirical literature has linked GDP growth (St. Clair, 2004; Shu, 2002), interest rates (Altunbas et al., 2014; Rajan, 2005; Borio & Zhu, 2008), market volatility (Laeven, 2014; Levine & Zervos, 1998) and market power (Boyd et al., 2006; Uhde & Heimeshoff, 2009) with bank performance and stability.

With regard to the research of Altunbas et al., (2014) there are at least two main ways in which low interest rates may influence bank risk. First, estimation of expected bank risk is largely influenced by its valuation, cash flows, and its income streams and low interest rates affect these indicators to a huge extent. For instance, the price of a financial asset would be boosted by low interest rates, which results in modifications in estimating the probability of default, loss given default, and volatilities. Borio and Zhu (2008) and Adrian and Shin (2009a, 2009b) found that this phenomenon will increase the risk-tolerance of a bank and will result in an expansion of a bank's balance sheet.

Second, lower cost short-term funding combined with low returns on governmental securities may increase motivation to 'search for yield' due to behavioral, contractual, or institutional reasons (Rajan, 2005). For example, life insurance companies and pension funds could have

minimum returns fixed by statute or contractually. Furthermore, Altunbas et al., (2014) suggest that lower interest rates for a prolonged period of time increases the risk for a bank. These findings mirror those of an earlier study by Gambacorta (2009) who also found a link between low interest rates and bank riskiness. We use the lag of the interest rate spread ($SPRD_{jt-1}$) to control for the impact of interest rate volatility on banks' stability. Based on the existing literature we anticipate a negative sign of both these measures with Z-score as a proxy for the stability of banks.

Another potential macro-economic variable which can affect the financial stability of the banking sector is price stability. A low and stable inflation rate supports corporations in long-term planning and, consequently, promotes investment. Borio and Lowe (2002) found that low and stable inflation promotes financial stability. However, they also warned that periods of low and stable inflation increases the likelihood that excess demand pressures will appear first in credit aggregates and asset prices, rather than in goods and services prices. An unexpected change in the inflation rate may have direct consequence for the funding stability of banks. For example, higher unexpected inflation may cause higher withdrawals from banks as investors would be more interested in keeping their savings in Real Assets that do not lose their value due to inflation. We control for the impact of inflation by utilizing the consumer price index (INF_{jt}). We expect a negative coefficient of INF_{jt} with the Z-Score as a stability measure.

The banking industry has changed considerably over the past 20 years due to the deregulation of banking activities, financial innovation and technical advancement. Goddard et al., (2007)

claims that this has led to higher merger and acquisition activities and hence competition within the domestic and international banking industry.

Vives (2011) suggests that there are two possible ways in which higher levels of competition can lead to banking instability. Firstly, by aggravating the coordination problem of depositors/investors on the liability side and fostering runs/panics. Secondly, by increasing incentives to engage in higher risk activity ultimately results in an increased probability of failure. Boyd and De Nicolo (2005) suggest that higher competition within the bank sector may lead to higher risk-taking. Research by Schaeck et al., (2009) also indicates that stability is inordinate in most competitive banking systems, given the lower probability of a financial crisis occurring. Uhde and Heimeshoff (2009), using aggregate data for the banking sectors of the EU-25, discuss the negative impact of market concentration (proxy for market competition) on financial stability. To control the impact of competition on bank stability we used 5-banks asset concentration ($CONS_{jt}$) as a proxy for competition.

We substitute the above independent variables in equations (1) and (1a) as specified below:

$$NSFR_{it} = \begin{array}{l} a_0 + a_1 \widetilde{STBL}_{it} + a_2 SIZE_{it} + a_3 LNG_{it} + a_4 LTOD_{it} + \\ a_5 IBAL_{it} + a_6 SPRD_{jt} + \widetilde{E}_{jt} \end{array} \quad (5)$$

$$STBL_{it} = \begin{array}{l} \beta_0 + \gamma STBL_{it-1} + \beta_1 \widetilde{NSFR}_{it} + \beta_2 SIZE_{it} + \beta_3 NONI_{it} + \\ \beta_4 OPER_{it} + \beta_5 TRCR_{it} + \phi_1 INF_{jt-1} + \phi_2 SPRD_{jt-1} + \\ \phi_3 CONS_{jt} + \phi_4 GFC_t + \lambda_t + \widetilde{\varepsilon}_{it} \end{array} \quad (5a)$$

There are control variables unique to the NSFR equation that includes loan growth (LNG_{it}), loan-to-deposit ratio ($LTOD_{it}$) and interbank-asset to interbank-liabilities ratio ($IBAL_{it}$). All these

variables reflect the asset and liability composition potentially affecting the NSFR ratio and consequently can affect the stability of a bank. .

5. Sample, Data, and Univariate Analysis

This section describes the sources of data used in this empirical investigation and its univariate analysis for the variables defined in the previous section. Our data comes from Bankscope for all commercial and savings banks from all countries except from Europe and North America. The initial data set consists of 1624 banks for which the financial data was available from Bankscope for the period 2003 to 2013. Since the calculation of the dependent variable requires a standard deviation we dropped all banks for which less than three years of continuous data was not available. We lost some observations due to missing data or obviously incorrect data. For example, we dropped those observations where total customer deposits and/or gross loans are zero. In addition, as the dependent variable and some of the control variables had a large positive or negative outlier we winsorized these covariates at the 1st and 99th percentile of their respective distributions. After these adjustments we were left with an unbalanced panel data of 948 banks from 85 countries with a total of 6,689 bank year observations. The data for macroeconomic variables was downloaded from The World Bank macroeconomic indicators.

Table 1 reports the descriptive statistics of each variable except for dummy variables in the sample after correcting for possible outliers. Beside mean and standard deviations, we also provide the quartile distribution for better understanding of the sample distribution. In terms of stability, large variations exist across banks as computed by Z-score. This indicates that, on

average, the return-on-assets has to fall by 101 times of their standard deviation to deplete the equity of the bank.

Among explanatory variables related to the stability equation banks, on average, had a NSFR of 1.21 and a median of 0.68 over the sample period albeit with large disparity especially in the upper half of the distribution where available stable funding exceeds the required funding. This indicates that large banks in our sample exceed the minimum requirement over the sample period. In terms of loan impairment charges, NPL_{it} has a mean of 2% suggesting that on average non-performing loans are under manageable limits for banks in the sample. There are obvious differences in the case of $NONI_{it}$. An average bank's proportion of income from fee-based activities was 28% although some banks earned more than 50% of their income by engagement in non-traditional activities. Banks, on average, earn operating income of 16% on average equity. In terms of total regulatory capital ratio ($TRCR_{it}$) banks in the sample generally exceeded the minimum requirement suggesting that banks maintain a buffer to avoid regulatory charges.

Generally, country-specific variables are within the normal range but do exhibit some differences. The interest rate spread between the lending and deposit rate ($SPRD_{jt}$) shows a tight competitive environment with average $SPRD_{jt}$ at 4%. This is further confirmed by higher concentrations of banking assets among the five biggest banks as reflected by $CONS_{it}$.

Among covariates related to the NSFR equation, loan growth (LNG_{it}) is generally positive with an average growth of 21%. Customer deposits are generally the major source of funding and loan growth with an average loan-to-deposit ratio ($LOTD_{it}$) of 87%. On the other hand, banks

have more inter-bank assets as compared with interbank-liabilities ($IBAL_{it}$). This suggests a positive indicator for individual banks. However, from a systemic perspective this reflects a banking system that relies considerably on funding investment from the banking sector.

The pairwise correlation matrix among the main variables is presented in Table 2. Most of the variables showed expected signs with strong significance levels. The relationship between $NSFR_{it}$ and $STBL_{it}$ is positive albeit insignificant. Among those variables that possibly reduce the stability of banks are the quality of the loan portfolio variable (NPL_{it}), participation in non-traditional banking activities ($NONI_{it}$), interest rates and competitive environments represented by interest rate spread (*SPRDit*), and asset concentration ($CONS_{it}$). Among the covariates that enhance the resilience of banks are the size of banks and the regulatory capital ratio.

6. Empirical methodology

The empirical estimation of equation (5) and (5a) via pooled ordinary least squares (OLS) regression ignores the panel structure of data and generally yields an upward-biased coefficient estimate for the lagged dependent variable in the presence of unobserved heterogeneity (Bond, 2002). Furthermore, inclusion of lagged values as explanatory variables makes the model dynamic in nature. Lagged values of explanatory variables may correlate with the combined error terms thus violate orthogonality assumption and create endogeniety. Due to the presence of simultaneous feedback and endogeniety, we compute equations (5) and (5a) by using the generalized method of moments (GMM) model as adopted by Arellano and Bover (1995) and Blundell and Bond (1998).

The two-step GMM estimator not only accounts for simultaneity bias but also controls the endogeniety problem. This is a robust indicator of contemporaneous errors and autocorrelation of unknown form looking at both panel and time series dimensions. However, as noted by Arellano and Bond (1991), Blundell and Bond (1998) and Roodman (2009), although the two-step GMM is asymptotically more efficient the reported standard errors are severely downward biased. To compensate, we used a finite sample correction to the two-step covariance matrix derived by Windmeijer (2005). This method allows for simultaneous adjustment of the NSFR and stability by considering both stability and the NSFR as endogenous, thereby allowing banks to determine their NSFR and stability levels simultaneously. The reliability of the dynamic panel system GMM estimates is checked using the Hensen's test for instrument validity and Arelano and Bond's (1991) test for serial uncorrelated error terms.

7. Regression Results and Discussion

Table 3 reports the estimation results of equations (5) and (5a) by using the dynamic panel data estimation two-step GMM model. The estimation results based on the GMM model is reported in Panel A. The diagnostic tests reported in Panel B indicate that the model is appropriate for this research. Hansen *J*-statistics for identifying restrictions tests the null hypothesis of valid instruments. The statistically insignificant *J*-statistics indicates that the instruments are valid in the system of GMM estimations. Furthermore, highly significant AR(1) and insignificant AR(2) are order correlated and further validates the use of the two-step GMM model for empirical estimations.

The estimation results as reported in Panel A of Table 3, are in line with expectations. The null hypothesis of no association between $NSFR_{it}$ and $STBL_{it}$ is rejected at 5% significance level suggesting that the maintenance of NSFR requirements under the Basel III accord has a positive impact on the stability of banks. These results are in line with the findings of Jiraporn et al., (2014) who argued that if the NSFR requirements were implemented during 2005-2009 it would have positively affected the Z-score.

The coefficient of a bank's size ($SIZE_{it}$) is positive and significant. This substantiates the 'too big to fail' phenomena wherein larger banks are more stable due to their access to sophisticated risk-management tools and to the 'lender of last resort' as argued by Hankenes and Schnabel (2011). However, Demirgüç-Kunt and Huizinga (2010) found that larger banks exhibited lower risk aversion over the period 1995 to 2007. Similarly, Maudos and de Guevara (2011) by examining a large sample of EU, American, and Japanese banks from 2001-2008 period, concluded that although size has a negative relationship with stability it is not linear and hence beyond the threshold level (for very large banks); an increase in bank size decreases the probability of bankruptcy. This difference in research findings can be attributed to different samples and sampling period.

The covariate of loan portfolio quality (NPL_{it-1}), as measured by the ratio of loan impairment charges to gross loans, is insignificant suggesting that a higher proportion of bad loans in a loan portfolio on average, does not affect the stability of banks. The non-significance of the NPL_{it-1} highlights the conservative nature of banks in the sample. Similarly, the coefficient of income diversification variable $NONI_{it}$ on bank stability, as measured by non-interest income to gross

revenue, is negative but insignificant. The insignificance of both $NONI_{it}$ and NPL_{it} suggests that since banks outside the European and North American regions focus on more traditional intermediation activities neither is suitable for explaining the stability of banks.

Income from core operations of banks ($OPER_{it}$) has a positive and significant impact on the stability of banks. Banks having higher operating profit are more stable. Our findings are in line with those of Hong et al., (2014) who linked profitability with failure hazard after using call report data of US banks from 2001 to 2011 and concluded that banks with higher profitability are more resilient to short-term shocks hence have less failure hazard. Jiraporn et al., (2014) linked profitability with Z-score and came to the same conclusion.

In line with buffer theory argument (Barrell et al., 2009; Miles et al., 2011; Caggiano & Calice, 2011) our results show that the regulatory capital ratio has a significantly positive effect on bank stability as measured by Z-score. Our results support buffer theory while nullifying arguments given by Agoraki et al., (2011) and Bolt and Tieman (2004) that higher costs arising from stringent capital requirements can harm bank stability. We therefore conclude that banks complying with regulatory capital requirements by maintaining higher risk-weighted capital are more stable as compared to their counterparts.

The coefficient of dichotomous variable GFC_t is positive and slightly significant suggesting that during the global financial crisis, the stability of banks in our sample was not affected. This result is not surprising as the most affected banking sectors during the crisis were those found in North America and Europe which are excluded from our sample.

Next, we control for country-specific macro variables possibly affecting the stability of banks. Our first macro variable is the inflation rate in the respective economies. INF_{jt} is negative and significant suggesting that banks in those countries where inflation is high are financially less stable as compared with banks from countries with lower inflation rates. This result is in line with the earlier findings of Borio and Lowe (2002) who found that low and stable inflation rates promote financial stability. However, caution is needed because they found that during periods of low and stable inflation there is also an increased likelihood that excess demand pressure shows up first in credit aggregates and asset prices rather than in goods and services prices.

We do not find any evidence that interest spread, as measured by $SPRD_{jt-1,}$ has any impact on the stability of banks in our sample. Concentration in the banking sector is measured by five-bank asset concentration and showed a significantly negative impact on the stability of banks. This result is in line with Vives (2011) who argued that in competitive markets bank instability rises due to higher risk-taking incentives.

Shrieves and Dahl (1992) suggest that non-performing loans represent risk in more traditional lines of business. Although Z-score is a composite measure of financial stability among banks in more traditional lines of business it is appropriate to confirm our findings using an alternative measure of stability as many banks in our sample are small. We used NPL_{it} as an alternative measure of bank stability. Since NPL_{it} is the sign of instability we expect a negative coefficient of $NSFR_{it}$ with NPL_{it} which will, in essence, show the stability function of NSFR. We re-

estimated the dynamic panel system GMM model with NPL_{it} as the dependent variable with the following specifications:

$$NSFR_{it} = a_0 + a_1 \widetilde{STBL}_{it} + a_2 SIZE_{it} + a_3 LNG_{it} + a_4 LTOD_{it} + a_5 IBAL_{it} + a_6 SPRD_{jt} + \widetilde{E}_{jt} \quad (6)$$

$$STBL_{it} = \beta_0 + \gamma NPL_{it-1} + \beta_1 \widetilde{NSFR}_{it} + \beta_2 SIZE_{it} + \beta_3 NONI_{it} + \beta_4 OPER_{it} + \beta_5 TRCR_{it} + \phi_1 INF_{jt-1} + \phi_2 SPRD_{jt-1} + CONS_{jt} + GFC_t + \lambda_t + \widetilde{\varepsilon}_{it} \quad (6a)$$

The estimation results based on NPL_{it} as dependent variables are reported in Table 4. Generally the results are in line with previous estimations except in the case of $NSFR_{it}$, $SIZE_{it}$ and GFC_t. We do not find any evidence that the imposition of the new NSFR regulation would impact on the more traditional measure of bank instability. This result is not surprising since the intent of the NSFR regulation is not to affect the risk-taking behavior of banks in more traditional lines of business. Similarly, the size of banks and their income streams from non-traditional banking activity is insignificant. The most notable difference is the change in sign of the global financial crisis dummy (GFC_t.) which is negative and significant as oppose to positive and significant in the case of Z-score as a dependent variable. This suggests that during the crisis the stability of banks were affected by more traditional lines of business.

8. Summary and Conclusion

The recent financial crisis (2007-2009) exposed banks due to their funding instability and illiquidity. Banks experienced funding mismatch due to financing long-term assets with short-term liabilities which triggered a chain reaction and resulted in a financial crisis. To address this

situation, and to try to minimize the likelihood of it happening again, the BASEL Committee on Banking Supervision (BCBS) instigated a new regulatory framework which required banks to maintain a Net Stable Funding Ratio (NSFR).

This study used Z-score as a measure of a bank's stability and tested the applicability of a NSFR as a tool to increase and strengthen a bank's stability. After controlling for possible endogeniety (between bank stability and the NSFR) robust evidence has been found that the NSFR requirement has a significant, positive, effect on bank stability. These findings validate the new regulatory framework under Basel III and favor its implementation.

Analysis was also conducted to investigate the channel through which the NSFR strengthens a bank's stability. We analyzed the relationship between the NSFR with that of non-performing loans (NPLs). Analysis indicates that the NSFR does have a negative effect on NPLs but it is insignificant. Hence, those banks having sufficient available funding in comparison to their required level of funding enjoy stable financial operations.

In summary, our results validate the Basel III regulations and conclude that NSFR as a funding stability ratio has the capability to increase the financial stability of banks. By considering Z-score as a measure of financial stability our results show, that after controlling for all other micro and macro elements of financial stability, NSFR is a positive contributor to financial stability.

Our research has identified two further areas of study. First, do investors assign a low credit risk-rating to banks with stable financial operations due to their reduced risk of failure? This can

be investigated by linking NSFR with the credit risk of a bank. Second, do our research findings also apply to Islamic banks? This can be investigated by replicating our research by substituting data from Islamic banks albeit with some modification to account for the different asset-liability structure of Islamic banks.

Table 1: Descriptive Statistics

			Quartiles				
Variable	Mean	S.D.	Min	25%	Mdn	75%	Max
$STBL_{it}$	3.14	1.01	-0.06	2.57	3.22	3.77	5.59
$NSFR_{it}$	1.21	1.59	0.06	0.37	0.68	1.55	11.70
$SIZE_{it}$	14.65	2.29	8.05	12.81	14.82	16.41	21.33
NPL_{it}	0.99	0.04	-0.47	0.99	0.99	1.00	1.2
$NONI_{it}$	0.28	0.17	0.00	0.16	0.26	0.38	0.87
$OPER_{it}$	0.16	0.14	0.00	0.06	0.14	0.24	0.67
$TRCR_{it}$	0.19	0.13	0.06	0.12	0.15	0.20	0.95
INF_{jt}	0.05	0.05	-0.08	0.01	0.04	0.07	0.47
$SPRD_{jt}$	0.04	0.03	-0.04	0.02	0.03	0.06	0.34
$CONS_{jt}$	0.71	0.16	0.40	0.59	0.69	0.81	1.00
LNG_{it}	0.21	0.35	-0.35	0.02	0.13	0.27	2.36
$LTOD_{it}$	0.87	0.58	0.11	0.63	0.76	0.94	4.65
$IBAL_{it}$	2.6	2.51	0.00	0.70	1.65	3.87	9.54

This table shows descriptive statistics of all sample banks from year 2003-2013. STBL is the measure of bank stability measured by Z-score. NSFR is the Net Stable Funding Ratio under BASEL III calculated using equation (3). SIZE is bank size (Natural log of Assets). NPL is non-performing loans and NONI is income from Non-Traditional Banking Activities. OPER is operating profit ratio and TRCR is total regulatory capital ratio. INF is inflation and SPRD is interest rate spread between the lending and deposit rates. CONS is the concentration of banking assets among the five biggest banks. LNG is Loan Growth and LTOD is loan-to-deposit ratio. IBAL is inter-bank assets to inter-bank liabilities.

Table 2: Pairwise Correlation Matrix

	$STBL_{it}$	$NSFR_{it}$	$SIZE_{it}$	NPL_{it}	$NONI_{it}$	$OPER_{it}$	$TRCR_{it}$	INF_{jt}	$SPRD_{jt}$	$CONS_{jt}$
$STBL_{it}$	1									
$NSFR_{it}$	0.0109	1								
$SIZE_{it}$	0.2227	-0.3318	1							
NPL_{it}	0.2350	-0.0994	0.1898	1						
$NONI_{it}$	-0.1667	0.2076	-0.2231	-0.1123	1					
$OPER_{it}$	0.0122	0.0860	-0.0633	0.0676	0.1575	1				
$TRCR_{it}$	0.0708	0.4420	-0.4159	-0.0824	0.2068	-0.0636	1			
INF_{jt}	-0.1375	0.2604	-0.5169	-0.1939	0.3006	0.2833	0.2300	1		
$SPRD_{jt}$	-0.1928	0.2419	-0.5380	-0.1975	0.3436	0.2806	0.3119	0.5231	1	
$CONS_{jt}$	-0.0476	0.1668	-0.1318	-0.0969	0.3321	0.1212	0.2345	0.1708	0.3206	1

This table shows Pairwise Correlation Matrix of all the sample banks from year 2003-2013. STBL is a measure of bank stability measured by Z-score. NSFR is the Net Stable Funding Ratio under BASEL III calculated using equation (3). SIZE is bank size (Natural log of Assets). NPL is non-performing loans and NONI is income from Non-Traditional Banking Activities. OPER is operating profit ratio and TRCR is total regulatory capital ratio. INF is inflation and SPRD is interest rate spread between the lending and deposit rates. CONS is the concentration of banking assets among the five biggest banks.

Table 3: Estimation results using the dynamic panel data estimation two-step GMM model

VARIABLES	Expected sign	$STBL_{it}$
Panel A: Covariate estimates		
$NSFR_{it}$	+	0.0089**
		(0.0038)
$SIZE_{it}$	+/-	0.0063***
		(0.0024)
NPL_{it-1}	-	0.0019
		(0.0037)
$NONI_{it}$	+/-	-0.0082
		(0.0361)
$OPER_{it}$	+	0.3095***
		(0.0454)
$TRCR_{it}$	+	0.2198**
		(0.1084)
GFC	+/-	0.0188*
		(0.0100)
INF_{jt-1}	-	-0.5995***
		(0.1297)
$SPRD_{jt-1}$	+	-0.2820
		(0.1865)
$CONS_{jt}$	-	-0.0543**
		(0.0227)
$STBL_{it-1}$		0.9654***
		(0.0055)
Constant		-0.0084
		(0.0476)
Panel B: Model fit		
F(11, 644)		3676.87 ***
AR(1) test stat		7.34***
AR(2) test stat		0.37
Hansen *J*-stat		467.74
Observations		3,194
Number of Banks		645

This table shows the estimation results of equations (5) and (5a) using the dynamic panel data estimation two-step GMM model. Dependent variable $STBL_{it}$ is z-score and measures of stability of banks in the sample. Sample period is from 2003-2013. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4: Estimation results based on NPL_{it} as dependent variables using the two-step GMM model

VARIABLES	*Expected sign*	(1) NPL_{it}
Panel A: Covariate estimates		
$NSFR_{it}$	-	-0.0021
		(0.0021)
$SIZE_{it}$	+	0.0001
		(0.0003)
$NONI_{it}$	+/-	0.0037
		(0.0039)
$OPER_{it}$	+	0.0241***
		(0.0090)
$TRCR_{it}$	+	0.0161
		(0.0117)
GFC	-	-0.0029**
		(0.0012)
INF_{jt-1}	-	-0.0651***
		(0.0180)
$SPRD_{jt-1}$	-	-0.0378
		(0.0273)
$CONS_{jt}$	-	-0.0090*
		(0.0049)
$STBL_{it-1}$		0.4716**
		(0.1863)
Constant		0.5284***
		(0.1819)
Panel B: Model fit		
F(10, 639)		2.61**
AR(1) test stat		2.61***
AR(2) test stat		1.55
Hansen *J*-stat		510.47
Observations		3,177
Number of id		640

This table shows the estimation results of equation (6a) using instrumental variable estimation technique. Sample period is from 2003-2013. Dependent variable $STBL_{it}$, is the ratio of Loan Impairment charges to average gross loans and measures the stability of banks in the sample. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.

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