Accepted Manuscript

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PII: S0275-5319(16)30185-4
DOI: http://dx.doi.org/doi:10.1016/j.ribaf.2016.07.031
Reference: RIBAF 562

To appear in: *Research in International Business and Finance*

Received date: 16-2-2016
Accepted date: 19-7-2016

Please cite this article as: Ly, Kim Cuong, Chen, Zhizhen, Wang, Senyu, Jiang, Yuxiang, The Basel III Net Stable Funding Ratio adjustment speed and systemic risk.Research in International Business and Finance http://dx.doi.org/10.1016/j.ribaf.2016.07.031

The Basel III Net Stable Funding Ratio adjustment speed and systemic risk

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Abstract

The theory on the timing of liquidity trades highlights two contrasting rational expectations equilibria for the liquidity adjustment speed effect, namely an immediate-trading equilibrium (trade at the onset of the liquidity shock) and a delayed-trading equilibrium (trade at the last resort). Using a partial adjustment model and an annual data sample of US bank holding companies from 1991 to 2012, we investigate the effect of Net Stable Funding Ratio (NSFR) adjustment speeds on systemic risk. We find that banks with the immediate-trading equilibrium tend to adjust the NSFR quickly in response to the Basel III liquidity requirement, thereby, reducing systemic risk. With the same level of the NSFR, our findings suggest that only the adjustment speed exerts a negative impact on systemic risk. Our evidence shows that small banks strengthen the effects of the negative impact of the NSFR adjustment speed on systemic risk. Our study sheds light on a real-time indicator of the NSFR for Basel III revisions before its implementation in 2018.

Keywords: Net Stable Funding ratio; Basel III; systemic risk; adjustment speed

JEL Classification: G200, G210, G280

1 Introduction

Liquidity pressure is the first overt sign of a banking crisis and has become a serious concern since the 2007-2009 financial crisis. In the post-crisis revisions, known as Basel III, the Basel Committee on Banking Supervision (BCBS 2013) introduced a quantity-based liquidity standard, Net Stable Funding Ratio (NSFR), to strengthen bank liquidity risk management practices. This represents a starting point to quantify individual banks' market-implied vulnerability to system-wide funding constraints during the period of stress. Faced with the new prudential standard, an open question that has recently been asked concerns whether the adjustment frictions of the NSFR affect systemic risk? Since the liquidity problem has escalated all systemic crises (Jobst 2014) , such a liquidity change should be reflected in each bank's adjustment speeds relative to the increase in stable funding in response to systemic liquidity risk. However, to the best of our knowledge, this specific issue has not been formally investigated to date. Our paper therefore draws attention to the market-based evaluation of the riskiness of the whole banking system by using a measure of dynamic exposure via a risk-adjusted value – the NSFR.

It is important to study the effect of the adjustment speed of the NSFR on systemic risk. First, the 2007–2009 financial crisis is a concrete evidence since banks across countries suffered liquidity shortages due to the dislocation of wholesale bank funding markets, and thus a total meltdown of the financial system (Acharya and Merrouche 2012, Billio et al. 2012, Afonso et al. 2011, Huang and Ratnovski 2011, Brunnermeier and Pedersen 2009). Hence, acknowledging how the new liquidity standard influences systemic risk is important in the Basel III reform process. Second, Basel III evaluates banks' long-term liquidity using the NSFR (Distinguin et al. 2013, Yan et al. 2012). The traditional liquidity requirement for individual bank does not work as systemic stability; however, the reaction of banks is a real response to policy makers.

Our paper departs from the intersection of two literatures on liquidity risk management. The first departure is the definition of the NSFR. King (2013) defines the NSFR as the ratio of the available amount of stable funding (ASF) divided by the required amount of stable funding (RSF). If the RSF is higher than the ASF, it implies that banks are exposed to the risk of selling assets at fire sale prices to repay the liabilities claim on demand. The NSFR is assessed according to market prices to generate a time-varying measure of funding risk and only excessive maturity mismatches indicates regulatory implications for the social costs of system-wide constraints in stress periods (Jobst 2014). The more the potential funding constraints are projected by a declining NSFR, the larger the expected losses from liquidity risk will be (Jobst 2014).

The second departure is the likelihood of falling below the boundary of the NSFR conditions on the individual funding choice and bank's experiencing of a liquidity shortage due to a common funding shock (Jobst and Gray 2013). Countervailing arguments challenge the view that when all banks face the same deterioration of stable funding, the way in which an individual bank treats the risk of selling assets at fire sales prices to repay the liabilities claim on demand has an impact on the degree of systemic risk.

Our hypotheses are put forward by the novel theory on the timing of liquidity trades introduced by Bolton et al. (2011) in terms of two rational scenarios, namely the immediate-trading equilibrium (trade at the onset of the liquidity shock) versus the delayed-trading equilibrium (trade at the last resort). In times of stress, banks face the choice between liquidating early before adverse selection problems and riding out the crisis at more depressed prices. In the immediate-trading equilibrium, higher future lemon problems cause an acceleration of trade (Akerlof 1970). Dornbusch (1991) argues that the higher the cost of failure is, the greater the incentives for rapid adjustment should be. If banks could adjust the funding risk quickly to reduce their individual expected losses, the joint probability of all banks experiencing a liquidity shortfall simultaneously will decline, hence reducing the systemic risk (Jobst 2014). Altogether, we propose the first hypothesis that banks with an immediate-trading equilibrium tend to adjust the NSFR quickly; therefore, the systemic risk can be reduced.

An opposite view, modelled by Bolton et al. (2011), shows that worssening asymmetric information leads to an increase in the cost of outside liquidity. Brunnermeier and Pedersen (2009) argue that a liquidity shock raises the expectation about the future volatility, therefore lowering the market liquidity. When the funding condition is tight, banks become more reluctant to take on positions. In other words, Bolton et al. (2011) emphasize that when the adverse selection problem becomes severe, the delayed-trading equilibrium occurs. When the market liquidity and lemon problems are highly sensitive to the change in the funding condition, liquidity spirals will ruin the stability of the system (Brunnermeier and Pedersen 2009). Therefore, we posit the second hypothesis that banks with the delayed-trading equilibrium tend to be reluctant to respond to an increased cost of funding, resulting in increased systemic risk.

A partial adjustment model has hence attracted considerable attention from the studies on the nature of the adjustment process (Flannery and Rangan 2006 , Leary and Roberts 2005, Hovakimian et al. 2001). However, this model has been significantly employed in the capital structure rather than the liquidity structure, leaving it largely unexplored in the bank liquidity literature. In this paper, we attempt to adapt this decent dynamic model to fill the gap and provide some novel empirical results about the impact of banks' liquidity adjustments on systemic risk.

Our data are obtained from two sources. The bank holding company (BHC) data are collected annually from the FRY-9 reports over the period from 1991 to 2012. The stock prices data come from the Center for Research in Security Prices (CRSP). We find that when banks adjust their liquidity promptly to comply with the new Basel III regulation, the systemic risk underlying the whole financial system is significantly undermined. Our finding shows that banks tend to adopt an immediate-trading equilibrium in response to the Basel III reform on the NSFR, therefore, reducing systemic risk, consistent with our first hypothesis. In the immediate-trading equilibrium, greater future lemon problems cause an acceleration of trade (Akerlof 1970). This is in line with our hypothesis suggesting that if banks adjust their funding risk quickly to reduce their individual expected losses, the joint probability of all banks experiencing a liquidity shortfall simultaneously will decline, hence reducing the systemic risk. Therefore, the long term benefit of combined actions leads to a more stabilized financial system and lower systemic risk. With the same level of the NSFR, our findings suggest that only the adjustment speed exerts a negative impact on systemic risk. Our evidence shows that small banks strengthen the effects of the negative impact of NSFR adjustment speed on systemic risk.

This paper is written at a time of significant Basel III reform of liquidity; therefore, it makes several contributions. First, we are the first to employ a partial-adjustment model of the NSFR in Basel III and we add more evidence to the literature on the adjustment speeds model (Flannery and Rangan 2006 , Leary and Roberts 2005, Hovakimian et al. 2001). Second, this paper contributes to our knowledge of how banks react to the NSFR requirement and its impact on systemic risk. From the theoretical point of view, our paper complements the work of Brunnermeier and Pedersen (2009) in that the delay regime reinforces the liquidity spirals, leading to higher systemic risk. As documented in Ratnovski (2013) study, which states that liquidity buffers and information asymmetry are strategic substitutes in liquidity management, our paper puts forward more evidence that banks tend to be in favour of building liquidity as quickly as possible to negate the cost of information asymmetry in the midst of squeezed funding markets.

Third, Jobst (2014) suggests that the current proposed liquidity standard of the NSFR in Basel III will be not able to determine the potential liquidity shortfall in time of stress. Using our results for BHCs in the US, we raised the interesting point that if liquidity shortfalls happen simultaneously, a joint slow speed of adjustment relative to the interlinkages in funding positions may expose the banking system to funding shocks. Therefore, failing to take into account the speed of liquidity adjustment would lead to an underestimation of the system-wide liquidity shortfall.

The liquidity requirement has more predictable power than the capital buffer in systemic effects (Cifuentes et al. 2005). Therefore, a number of recommendations for policy makers and practitioners are provided. First, our paper recommends a closer supervisory practice to identify the liquidity problems of a particular bank. By observing the adjustment speed of liquidity, the supervisor can acknowledge that the level of bank’s contribution to the overall systemic risk. Second, an integrated approach in terms of liquidity and adjustment speed to reach that level is advisable for practitioners given the interaction between the liquidity regulation and the liquidity decision made by banks. Banks should realize the importance of their speed in adjusting their liquidity level in periods of crisis.

Third, this paper highlights the importance of the adjustment speed of bank liquidity, which can give regulatory authorities insights not only into strengthening the liquidity ratio as required by the new Basel III but also into reinforcing the regulation of their reaction speed to reach the target ratio. Given that the short-term wholesale funding's features raise the exposure not only to the interbank markets but also to the whole financial system, hence, triggering systemic risk episodes (López-Espinosa et al. 2012), the target of the NSFR for more stable funding and its adjustment rate must be increased to comply with the Basel III liquidity requirement to keep the probability of failing the regulatory Basel III requirement constant in the event of banks' inability to extend the maturity of wholesale funding. Therefore, a real-time indicator of the NSFR is a recommended solution as a meaningful measure of their effect on systemic risk in the revisions of Basel III before its implementation in 2018.

The remainder of the paper is organized as follows. Section 2 develops hypotheses. Section 3 describes data and methodology. The empirical results are presented in Section 4. Finally, Section 5 concludes the discussion.

2 The relationship between the adjustment speed of Net Stable Funding Ratio and the systemic risk

Under the circumstances that all distortions are removed, resources can be reallocated without cost. However, in the real word, resources may not be reallocated instantaneously without incurring costs (Nsouli et al. 2005). Jobst (2014) emphasizes that the adjustment of banks' liquidity risk profile lies in their banks' capacity to cover the costs of all the expected losses and meet the minimum threshold of market-based stable funding.

The funding choice in the new prudential reform, Basel III, aims to limit the maturity transformation of banks and the NSFR is regarded as a unit of measurement to assess banks' liquidity profile at risk from their liquidity creation activities. King (2013) defines that the NSFR as the ratio of the available amount of stable funding (ASF) divided by the required amount of stable funding (RSF). It limits bank liquidity risk by restricting the maturity mismatch between short-term liabilities and short-term assets. If the RSF is higher than the ASF, it implies that banks are exposed to the risk of selling assets at fire sales prices to repay the liabilities claim on demand. Therefore, the NSFR explicitly shows the threshold above which banks may face difficulties in transformation risk. However, based on their individual conditions, banks may face different social cost of their funding choice (Jobst 2014). The proposed Basel III liquidity standards highlights that the NSFR component is assessed according to market prices to generate a time-varying measure of funding risk and only excessive maturity mismatches indicates regulatory implications for the social costs of system-wide constraints in periods of stress (Jobst 2014).

Theoretically, the fact that each bank holds a large liquidity buffer may decrease the likelihood that multiple financial institutions will face liquidity shortfall problems (Jobst 2014). However, Aikman et al. (2010) argue that this rationale differs in bank risk-taking incentives related to diverse funding structures and their impact on systemic liquidity risk. The more the potential funding constraints are projected by a declining NSFR, the larger the expected losses from liquidity risk will be (Jobst 2014). Therefore, according to Nsouli et al. (2005), rapid adjustment is greatly preferable in a crisis situation. The attention here centres on the importance of the adjustment speeds of liquidity in times of stress.

The novel theory of the timing of liquidity trades originated by Bolton et al. (2011) proposes that banks may face two rational expectations, namely the immediate-trading equilibrium (trade at the onset of the liquidity shock) versus the delayed-trading equilibrium (trade at the last resort). The stress scenario is determined by market factors affecting the components of the NSFR (Jobst and Gray 2013). The likelihood of falling below the boundary of the NSFR conditions is based on the individual funding choice and banks' experience of a liquidity shortage due to a common funding shock. The expected loss from the variation of each bank's NSFR is treated as the joint probability of all banks experiencing a liquidity shortfall simultaneously. In two equilibriums, banks could face the trade-off between the cost of building liquidity and the lemon problems (Bolton et al. 2011). Countervailing arguments challenge the view that when all banks face the same deterioration of stable funding, the way in which individual banks treats the risk of selling assets at fire sales prices to repay the liabilities claim on demand influences the degree of systemic risk.

When the cost of liquidity and asymmetric information is low enough, banks find it optimal to combine the two in their liquidity risk management (Ratnovski 2013). However, when facing greater lemon problems, banks tend to employ the immediate-trading equilibrium to save the cost of building a liquidity buffer. In the immediate-trading equilibrium, greater future lemon problems cause an acceleration of trade (Akerlof 1970). Bolton et al. (2011) argue that it is cheaper to raise funding at the onset of a liquidity shock. To prevent an accelerating funding cost when the asymmetric information worsens, banks choose to obtain liquidity quickly at the very first stage. It is evident that rapid reforms lead to lower adjustment costs, because rapid reforms increase the incentives to relocate resources (Mussa 1984). Dornbusch (1991) also argue that the higher the cost of failure, the greater the incentives for rapid adjustment should be. Furthermore, the greater the adjustment effort is, the higher the probability that success will be achieved. If banks adjust the funding risk quickly to reduce their individual expected losses, the joint probability of all banks experiencing a liquidity shortfall simultaneously will decline, hence reducing the systemic risk. Altogether, we postulate the following

Hypothesis 1: A higher adjustment speed of the NSFR in the immediate-trading equilibrium is more likely to reduce systemic risk.

In striking contrast, the delayed-trading equilibrium economizes on aggregate liquidity (Bolton et al. 2011). Particularly, the vulnerability of the stable funding of individual banks is treated as the hazard rate of the ASF falling below the present value of the RSF over the given time period. Therefore, this indicates that only the funding choice that breaks the threshold of regulatory expectation can be related to the social cost of systemic liquidity risk (Jobst 2014).

Ratnovski (2013) argues that banks tend to obtain market-based wholesale funding to manage their liquidity needs. Worsening asymmetric information leads to an increase in the cost of outside liquidity (Bolton et al. 2011). Brunnermeier and Pedersen (2009) argue that a liquidity shock raises the expectation about the future volatility, therefore, lowering the market liquidity. When the funding condition is tight, banks become more reluctant to take on positions. In other word, the delayed regime is adopted. When the market liquidity and lemon problems are highly sensitive to the change in the funding condition, liquidity spirals will ruin the stability of the system (Brunnermeier and Pedersen 2009). A higher perceived risk profile of each bank as the degree of stable funding decrease introduces market-induced linkages among financial institutions (Jobst 2014).

According to Kyle and Xiong (2001), contagion is defined as the rapid spread from one market to another of declining prices and declining liquidity, leading to an increased correlation among financial intermediaries. With the delayed response, banks tend to suffer from the rapid spread in the midst of lemon problems. The mechanism leads to contagion and therefore an increase in systemic risk making the crisis worse (Allen and Gale 1998). Collectively, we hypothesize that:

Hypothesis 2: A higher adjustment speed of the NSFR in the delayed-trading equilibrium is more likely to increase systemic risk.

3 Methodology and data

3.1 Variable definitions

3.1.1 Adjustment speed of the Net Stable Funding Ratio

Firstly, we follow Distinguin et al. (2013) to calculate the net stable funding ratio, in whichhigher values of the net stable funding ratio indicate higher liquidity. It is calculated as the ratio of the available amount of stable funding to the required amount of stable funding. We calculate the NSFR as follows:

$$NSFR = \frac{Available\ amount\ of\ stable\ funding}{Required\ amount\ of\ stable\ funding} \tag{1}$$

$$NSFR = \frac{0.7*(\text{demand deposits}+\text{saving deposits})+1*(\text{long-term liabilities}+\text{equity})}{0.5*(\text{long-term marketable assets}+\text{customer acceptances})+0.85*(\text{consumer loans})+1*(\text{commercial loans}+\text{other loans}+\text{other assets}+\text{fixed assets})}$$

In the partial adjustment model, the bank' current NSFR is a weighted average of its target NSFR ratio:

$$NSFR_{it} - NSFR_{it-1} = \lambda_i (NSFR^*_{it} - NSFR_{it-1}) + \varepsilon_{it} \quad (2)$$

where $NSFR_{it}$ is the return on the total assets for bank i in year t. $NSFR^*_{it}$ is the target return on the total assets for bank i in year t. λ means the proportional adjustment during one year for bank I; in this context, the lambda captures how far the sample banks are operating away from their expected returns. Alternatively, the NSFR is predicted to mean revert to a target level, which can be determined by a cross-sectional model:

$$NSFR^*_{it} = \beta_i X_{it-1} + U_{it} + \varepsilon_{it} \quad (3)$$

where X_{it-1} is a vector of bank and macroeconomic characteristics that can influence the NSFR. U_{it} is the fixed effects to control for unobserved firm heterogeneity. Substituting equation (3) into equation (2) and rearranging the yields, it produces the following specification:

$$NSFR_{it} = \lambda_i \beta_i X_{it-1} + (1-\lambda_i) NSFR_{it-1} + \lambda_i (U_{it}) + \varepsilon_{it} \quad (4)$$

From equation (4), it can be seen that In the partial adjustment model, the bank's current NSFR is a weighted average (with the l_i between 0 and 1) of its expected NSFR*, and the NSFR of its previous period, as well as the unobservable fixed effects and random shocks. Regarding to the adjustment speed, if the λ is small, it means that the adjustment speed is slow, representing a bank's return on assets (ROA) taking a long time to return to its target after a shock. On the other hand, the $(1-\lambda_i)$ term before the lag value of the ROA in equation (4) is treated as an inertial fact in the partial adjustment model.

In the partial adjustment model, the expected NSFR* is unavailable and it is not necessarily constant over time. Here we follow Fama and French (2000) in building a model to estimate the expected NSFR*. The cross-sectional model for estimating the NSFR * can be summarized as:

$$NSFR^*_{it} = \beta_0 + \beta_1 DD_{it-1} + \beta_2 ROA_{it-1} + \beta_3 SIZE_{it-1} + \beta_4 Capital_{it-1} + \beta_5 TIER1_{it-1} + \varepsilon \quad (5)$$

DD is a dummy that equals 1 if the bank pays dividends 0 otherwise, this dummy is used to capture the non-linear relationship between dividends issuance and profitability. ROA is the net income over total assets. SIZE is the natural logarithm of total assets. CAPTAL is the total equity to total assets. TIER1 is the TIER1 capital over the total assets.

Our estimation of the expected NSFR is similar to that of the standard partial adjustment model, which is widely used in the capital structure measure of the future target of the capital ratio (Flannery and Rangan 2006). The expected NSFR* is obtained through equation (5) using the Fama-Macbeth regressions. After obtaining the estimated NSFR*, we apply equation (2) using a simple autoregressive model to estimate each bank's NSFR adjustment speed.

3.1.2 Systemic risk measure

We use two systemic measures, △CoVaR (Adrian and Brunnermeier 2008) and the systemic expected shortfall (SES) (Acharya et al. 2010).[1]

3.1.3 Control variables

The bank-specific control variables include the bank size (the natural logarithm of total assets) (DeMiguel et al. 2013, Haan and Poghosyan 2012, Hakenes and Schnabel 2011, Demsetz and Strahan 1999, Gennotte and Pyle 1991), capital ratio, diversification (the noninterest income divided by the total operating income), local market power (the deposit concentration for the local markets in which the bank is

1 Please refer to Appendix A for details.

present (Berger and Bouwman 2013), ROA, non-performing loans, off balance sheet (OBS) activities and loan loss provisions. We control the macro-economic environment using the real GDP growth (Vassalou and Xing 2004) and inflation rate. A description of the variables is provided in Appendix B.

3.2 Methodology

We examine the following regression model by applying the fixed-effects model:

$$SystemicRisk_{i,t} = \beta_0 + \beta_1 Adjusted\ speed\ NSFR_{i,t-1} + \beta_2 Basel\ III_{t-1} + \beta_3 Adjusted\ speed\ NSFR_{i,t-1} * Basel\ III_{t-1} + \beta_v X_{i,t-1} + \varepsilon_{i,t} \quad (6)$$

where $SystemicRisk_{i,t}$ is the systemic risk for BHC *i* in year *t* gauged using two different proxies, which are described in Appendix A. The adjustment speed $NSFR_{i,t-1}$ is the NSFR adjustment speed of BHC *i* in year *t-1*. Basel III is a dummy variable indicating the implementation of the regulation and equals 1 after the year 2009, and 0 otherwise. $Adjusted\ speed\ NSFR_{i,t-1} * Basel\ III_{t-1}$ is the interaction term between the NSFR adjustment speed and the Basel III dummy. $X_{i,t-1}$ is the vector of a group of control variables representing BHC characteristics as well as several macroeconomic statistics that may have an impact on systemic risk. All the independent variables are lagged by 1 year.

3.3 Data and descriptive statistics

Our data are obtained from two sources. The BHC data are collected annually from the FRY-9 reports over the period from 1991 to 2012. The stock prices data come from the Center for Research in Security Prices. We only survey the BHCs in the United States.

Table 1 presents the descriptive statistics. We find that the average BHC has a capital ratio of 11%, which demonstrates that most of the BHCs in our sample are well capitalized and in general follow the regulation requirement. The revenue sources of BHCs tend not to be largely diversified and their median ROA is only 1% of their lagged assets which is also much lower than that of non-financial firms, by Lemmon et al. (2008) to be 12%. This matches the earlier finding that stricter regulation relative to non-financial firms makes banking appear to be a relatively safe and, correspondingly, low-return industry (Gropp and Heider 2010).

In terms of the adjustment speed of the NSFR, the final sample presents a certain degree of heterogeneity, with BHCs above the upper quartile having roughly twice the adjustment speed of those below the lower quartile. This indicates that those BHCs at the bottom react fairly slowly in changing their liquidity to reach the target ratio, which brings potential risk to the whole financial system.

With regard to systemic risk, the first measure $\Delta CoVaR$ has a mean value of -3.48% indicating an average 3.48% loss of the entire system returns contributed by each bank's marginal impact. The mean value of the second measure *SES*, is 1.92%, suggesting that the banking industry has roughly a 1.92% expected equity loss below the target level conditional on a crisis scenario.

Both results are lower than those found by Brunnermeier et al. (2012) and Acharya et al. (2011). Perhaps this is mainly because they use data from 1986 to 2008, whereas our sample includes the entire financial crisis period of 2007-2009, which significantly drags down the average value for both measures of systemic risk.

4 Empirical results

4.1 The impact of the adjustment speed of liquidity on systemic risk

In this part, we mainly discuss the impact of the liquidity requirement imposed by Basel III on systemic risk. Specifically, we want to test how the NSFR adjustment speed under the new regulatory pressure of Basel III influences systemic risk.

As reported by Table 2, we find that the interaction of the NSFR adjustment speed and the Basel III dummy appears to be robust and significant when we use the

SES to quantify the systemic risk, consistent with our first hypothesis. In the immediate-trading equilibrium, greater future lemon problems cause an acceleration of trade (Akerlof 1970). This confirms our hypothesis in the sense that when banks adjust their liquidity promptly to comply with the new Basel III regulation, the systemic risk underlying the whole financial system is significantly undermined. Our findings suggest that banks tend to adopt an immediate-trading equilibrium in response to the Basel III reform of the NSFR to save the cost of building a liquidity buffer. If banks adjust their funding risk quickly to reduce their individual expected losses, the joint probability of all banks experiencing a liquidity shortfall simultaneously will decline, hence reducing the systemic risk.

Liquidity Creation is used as an alternative liquidity adjustment speed in our study. On the other hand, we do not find consistently significant effects of the adjustment speed of either the NSFR or the Liquidity Creation on systemic risk. As a matter of fact, it is not difficult to understand that the interaction of the Basel III regulation and banks' corresponding increased speed of NSFR adjustment plays an essential part in relieving systemic risk.

Arguably, the greater pressure imposed by Basel III on liquidity regulation forces banks to increase their liquidity adjustment speed to maintain a certain probability of complying with the regulatory requirements, very much like the action that banks take for the adjustment speed of their capital ratios (Memmel and Raupach 2010, Kleff and Weber 2008, Ediz et al. 1998, Shrieves and Dahl 1992). The higher adjustment speed shortens bank's reaction time in the case of falling below the required liquidity ratio, thus reducing the likelihood of liquidity risk. The longer term benefit of combined actions leads to a more stabilized financial system and lower systemic risk. Our main result remains consistent when using the measure of Liquidity Creation. Hence, our finding proves a clear role of the adjustment speed of liquidity to prevent systemic risk.

In addition to the above particularly focused explanatory variables, we notice that the bank capital ratio, non-performing loans and local market power as well as the GDP growth at the nation level all have significant influences and their effects remain consistent for both the measures of systemic risk employed in our analysis. The other variables such as diversification, ROA and OBS activities do not appear to have uniform impacts or consistent significance in either regression. This implies that these individual BHC characteristics do not augment the additional apparent effects on systemic risk.

4.2 Banks with similar liquidity levels: do their NSFR adjustment speeds matter?

Our above estimation procedure assumes that there is symmetric behaviour between the immediate-trading equilibrium and the delayed-trading equilibrium for both banks that have a below target NSFR and those that exceed it. Brunnermeier and Pedersen (2009) suggest that there is commonality of liquidity across assets when funding shocks occur. Other things being equal, banks with greater liquidity are in a better position than banks with lower liquidity in response to liquidity shocks. Since banks hold more liquidity in excess of the NSFR minimum requirement, highly-liquid banks tend to adjust their liquidity less during times of stress to avoid liquidity shortfalls. Thus, one may argue that if banks hold a different amount of NSFR in excess of regulatory requirements, this may in turn indicate differences in the adjustment speed in response to liquidity shocks. Therefore, the traditional argument on liquidity does not discriminate among banks with the same level of liquidity facing different adjustment speeds. To address this issue, we conduct a further robustness test in this section by employing the propensity score-matching method.

In particular, we compare the effect of the NSFR adjustment speed on systemic risk between banks with a high NSFR adjustment speed and those with a low NSFR adjustment speed given that banks have other similar characteristics. The dependent variable is a dummy variable equal to 1 for banks with a high NSFR adjustment speed (with a value higher than average) and 0 otherwise. We match similar NSFR levels between individuals with low and high NSFR adjustment speeds. As the portfolio choices made by highly-liquid banks may differ from those made by banks with low-liquidity, their business could be less sensitive to the shock. This, in turn, causes highly-liquid banks to react less to a liquidity shock. Therefore, we also match two groups of banks by a number of other bank-specific factors, such as bank size, capital ratio, diversification ratio, local market power, ROA, non-performing loans, OBS activities, loan loss provisions, real GDP growth rate and inflation rate. These bank characteristics may be factors distinguishing among banks with the same NSFR levels. Table 3 reports the results.

Panel A of Table 3 reports the probit regression estimates of the propensity to provide a high liquidity adjustment speed. Banks with a higher NSFR adjustment speed tend to have less capital, higher diversification, greater local market power, a lower ROA, and more OBS activities than those with a lower NSFR adjustment speed. Panel B of Table 3 shows that banks with a high NSFR adjustment speed tend to reduce systemic risk more than their counterparts with a low NSFR adjustment speed after sample matching. The Liquidity Creation measure presents the same findings. Our evidence represents a further robustness check to confirm our main findings.

To completely address completely the concern that it is not the NSFR level but the adjustment speed of the NSFR that matters, we provide a further robustness check by examining the impact of the liquidity level on systemic risk. Table 4 reports the result.

As shown in Table 4, neither the liquidity indicator nor the interaction term of liquidity indicators*Basel III influences systemic risk. Our finding again confirms that only the adjustment speed could reflect the heterogeneity in banks' influences on systemic risk. Overall, banks are subject to different adjustment speeds of their liquidity rather than their liquidity level under the Basel III reform with regard to their effect on systemic risk.

4.3 Bank size: Different effects of NSFR adjustment speeds on systemic risk

According to Jobst (2014), some banks are systemically more important than others with respect to the contributions of their funding decisions to systemic risk. Freixas et al. (2000) also document that regulators adopt a too-big-to-fail approach to deal with large financial institutions. The goal of this section, therefore, is to examine whether the effect of the NSFR adjustment speed on systemic risk deviates according to the bank size. To facilitate this comparison, we split our sample into three sub-samples, as follows (i) small banks, (ii) medium banks and (iii) large banks. Small banks are those banks that have total assets of less than $3 billion, medium banks are those banks with total assets between $3 billion and $10 billion and large banks are those that have total assets of more than $10 billion. Panels A, B and C in Table 5 report the results, respectively.

As indicated in panels A, B, and C of Table 5, we find that our main results holds for small banks only with a negative and significant coefficient of adjusted speed*Basel III, indicating that small banks tend to employ an immediate-trading equilibrium to adjust their NSFR quickly, thus leading to a decrease in systemic risk. The results for medium and large banks are not significant, implying that medium and large banks behave differently from their small counterparts. A possible explanation could be that large and medium banks can safely access central bank lending facilities to prevent the sudden run-off of available funding under stress (Jobst 2014). In contrast to medium and large banks, without a generous source from the central banks, the adjustment speed of the NSFR tends to be much more important for small banks due to the high costs associated with obtaining whole-sale funding.

5 Conclusion

Our paper departs from the theory of the timing of liquidity trades modelled by Bolton et al. (2011) in terms of two rational scenarios, namely the immediate-trading equilibrium (trade at the onset of the liquidity shock) versus the delayed-trading equilibrium (trade at the last resort). In the immediate-trading equilibrium, greater future lemon problems cause an acceleration of trade. An opposite view, modelled by Bolton et al. (2011), shows that worsening asymmetric information lead to an increase in the cost of outside liquidity, hence, the delayed-trading equilibrium occurs.

We employ a partial adjustment model along with annual bank holding company data from the FRY-9 reports over the period from 1991 to 2012 and stock price data from the Center for Research in Security Prices. Our findings show that banks tend to adopt an immediate-trading equilibrium in response to the Basel III reform on the NSFR, therefore reducing systemic risk, consistent with our first hypothesis. If banks adjust the funding risk quickly to reduce their individual expected losses, the joint probability of all banks experiencing a liquidity shortfall simultaneously will decline, hence, reducing the systemic risk. With the same level of the NSFR, our findings suggest that only the adjustment speed exerts a negative impact on systemic risk. Our evidence shows that small banks strengthen the effects of the negative impact of the

NSFR adjustment speed on systemic risk.

A real-time indicator of the NSFR is recommended as a meaningful measure of the effect on systemic risk in the revisions of Basel III before its implementation in 2018.

Appendix A: Empirical estimation method of Delta CoVaR

To estimate this measure of individual bank's systemic risk contribution, we need to calculate two VaR s for each bank, namely $CoVaR_q^{system|i}$ and $CoVaR_q^{system|i,median}$. For the systemic risk conditional on bank i in distress ($CoVaR_q^{system|i}$), run a 1% quantile regression using the weekly data to estimate the coefficients α^i, β^i, $\alpha^{system|i}$, $\beta^{system|i}$ and $\gamma^{system|i}$:

$$R_t^i = \alpha^i + \beta^i Z_{t-1} + \varepsilon^i \tag{AP 1}$$

$$R_t^{system} = \alpha^{system|i} + \beta^{system|i} Z_{t-1} + \gamma^{system|i} R_{t-1}^i + \varepsilon^{system|i} \tag{AP 2}$$

And run a 50% quantile (median) regression to estimate the coefficients $\alpha^{i,median}$ and $\beta^{i,median}$:

$$R_t^i = \alpha^{i.median} + \beta^{i.median} Z_{t-1} + \varepsilon^{i.median} \tag{AP 3}$$

where R_t^i is the weekly growth rate of the market-valued assets of bank i at time t:

$$R_t^i = \frac{MV_t^i \times Leverage_t^i}{MV_{t-1}^i \times Leverage_{t-1}^i} - 1 \tag{AP 4}$$

and R_t^{system} is the weekly growth rate of the market-valued total assets of all N banks in the financial system at time t:

$$R_t^{system} = \sum_{i=1}^{N} \frac{MV_{t-1}^i \times Leverage_{t-1}^i \times R_t^i}{\sum_{j=1}^{N} MV_{t-1}^j \times Leverage_{t-1}^j} \tag{AP 5}$$

In the equations above, MV_t^i is the market value of bank i's equity at time t, and $Leverage_t^i$ is bank i's leverage defined as the ratio of total asset and equity market value at time t: $Leverage_t^i = Asseet_t^i / MV_t^i$. It is noted that when we calculate the asset return of the entire financial system in equation above, the individual bank's asset return is value-weighted by its total asset proxied by the product of equity market value (MV) and leverage at time $t-1$.

Z_{t-1} is the vector of macroeconomic and finance factors in the previous week, including market return, equity volatility, liquidity risk, interest risk, term structure, default risk and real-estate return. We obtain the value-weighted market returns from the database of S&P 500 Index CRSP Indices Daily. We use the weekly value-weighted equity returns (excluding ADRs) with all distributions to proxy for the market return. Volatility is the standard deviation of log market returns. Liquidity risk is the difference between the three-month LIBOR rate and the three-month T-bill rate. For the next three interest rate variables we calculate the changes from this week t to $t-1$. Interest rate risk is the change in the three-month T-bill rate. Term structure is the change in the slope of the yield curve (yield spread between the 10-year T-bond rate and the three-month T-bill rate). Default risk is the change in the credit spread between the 10-year BAA corporate bonds and the 10-year T-bond rate. All interest rate data is obtained from the U.S. Federal Reserve website and compustat Daily Treasury database. Real estate return is proxied by the Federal Housing Finance Agency's FHFA House Price Index for all 50 U.S. states.

Hence we predict an individual bank's VaR and median asset return using the coefficients $\hat{\alpha}^i$, $\hat{\beta}^i$, $\hat{\alpha}^{i,median}$ and $\hat{\beta}^{i,median}$ estimated from the quantile regressions of equation (AP 1) and (AP 3):

$$VaR_{q,t}^i = \hat{R}_t^i = \hat{\alpha}^i + \hat{\beta}^i Z_{t-1} \tag{AP 6}$$

$$R_t^{i,median} = \hat{R}_t^i = \hat{\alpha}^{i,median} + \hat{\beta}^{i,median} Z_{t-1} \tag{AP 7}$$

The vector of state variables Z_{t-1} is the same as in equation (AP 1) and (AP 3).

After obtaining the unconditional VaR s of an individual bank i ($VaR_{q,t}^{i}$) and that bank's asset return in its median state ($R_t^{i,median}$) from equation (10) and (11), we predict the systemic risk conditional on bank i in distress ($CoVaR_q^{system|i}$) using the coefficients $\hat{\alpha}^{system|i}$, $\hat{\beta}^{system|i}$, $\hat{\gamma}^{system|i}$ estimated from the quantile regression of equation (AP 2).

Specifically,

$$CoVaR_{q,t}^{system|i} = \hat{R}_t^{system} = \hat{\alpha}^{system|i} + \hat{\beta}^{system|i} Z_{t-1} + \hat{\gamma}^{system|i} VaR_{q,t}^{i} \quad \text{(AP 8)}$$

Similarly, we can calculate the systemic risk conditional on bank i functioning in its median state ($CoVaR_q^{system|i,median}$) as:

$$CoVaR_{q,t}^{system|i,median} = \hat{\alpha}^{system|i} + \hat{\beta}^{system|i} Z_{t-1} + \hat{\gamma}^{system|i} R_t^{i,median} \quad \text{(AP 9)}$$

Bank i's contribution to systemic risk is the difference between the financial system's VaR if bank i is at risk and the financial system's VaR if bank i is in its median state:

$$\Delta CoVaR_{q,t}^{i} = CoVaR_{q,t}^{system|i} - CoVaR_{q,t}^{system|i,median} \quad \text{(AP 10)}$$

Note that this is same as equation (4) with an additional subscript t to denote the time-varying nature of the systemic risk in the banking system. As shown in the quantile regressions of equation (AP 1) and (AP 3), we are interested in the VaR at the 1% confident level, therefore the systemic risk of individual bank at $q = 1\%$ can be written as:

$$\Delta CoVaR_{1\%,t}^{i} = CoVaR_{1\%,t}^{system|i} - CoVaR_{1\%,t}^{system|i,median} \quad \text{(AP 11)}$$

Appendix B

Variable Description	
Dependent Variables	
Delta CoVaR	ΔCoVaR, which is defined as the difference between the conditional value at risk of the financial system, is conditional on an institution being in distress (Adrian and Brunnermeier, 2008). Here the ΔCoVaR is the difference between the CoVaR conditional on a bank being in distress and the CoVaR conditional on a bank operating in its median state.
SES	SES is short for Systemic Expected Shortfall (Acharya et al., 2010). It is the expected amount that a bank is undercapitalized in a systemic event in which the entire financial system is undercapitalized.
Regulation Dummy	
Basel III Dummy	The dummy for BASEL III enaction. It equals to 1 after year 2009, and 0 otherwise.
Liquidity Regressors	
Adjusted Speed of Liquidity Creation	Liquidity creation is bank's liquidity indicator, defined by Berger and Bouwman (2009). We apply partial adjustment model to measure the speed of banks' reaction to BASEL regulation. Every bank has an overall time-invariant adjustment speed (Oztekin and Flannery, 2012).
Adjusted Speed of I_NSFR	I_NSFR is the inverse of Net Stable Funding Ratio (NSFR), which is another liquidity indicator. Detailed definition can refer to Distinguin, Roulet, Tarazi (2013). We apply partial adjustment model to measure the speed of banks' reaction to BASEL regulation. Every bank has an overall time-invariant adjustment speed (Oztekin and Flannery, 2012).
Control Variables	
Bank Size	Bank size is defined as the natural logrithm of individual's total assets.
Capital Ratio	Capital ratio is the ratio of bank capital and reserves to total assets. Capital and reserves include funds contributed by owners, retained earnings, general and special reserves, provisions, and valuation adjustments.
Diversification Ratio	Diversification is defined as noninterest income divided by total operation income.
Local Market Power	Local market power is defined as the deposit concentration for the local markets in which the bank is present (Berger and Bouwman, 2013)
ROA	ROA is the profitability indicator, which is bank's return on assets.
Non-Performing Loans	Non-performing loans is the amount of loans past due 90 days divided by total assets.
Off Balance Sheet Activities	Off balance sheet activities are the amount of bank's off balance sheet activities divided by total assets.
Loan Loss Provisions	The amount of expense set aside as an allowance for bad loans (customer defaults, or terms of a loan have to be renegotiated, etc), divided by total assets.
Real GDP Growth Rate	Annual GDP growth rate.
Inflation Rate	Annual inflation rate

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Table 1 Summary Statistics for All Sample Banks

This table shows the descriptive statistics, including mean, median, 25% and 75% quantile, and standard deviation of our panel data with 2191 commercial banks during the period of 1997 to 2012, contributing to a total observation of 15455. Dependent variables are two systemic risk measurements: i) ΔCoVaR which is defined as the difference between the conditional value at risk of the financial system conditional on an institution being in distress (Adrian and Brunnermeier, 2008); and ii) SES which is short for Systemic Expected Shortfall (Acharya et al., 2010), defined as the expected amount that a bank is undercapitalized in a systemic event in which the entire financial system is undercapitalized. Key regressors are two liquidity reaction variables: the adjusted speeds of i) liquidity creation (Berger and Bouwman, 2009); and ii) inverse of NSFR which is the inverse of net stable funding ratio (BIS, 2009). The adjusted speed is used to measure individual bank's reaction to Basel regulation, estimated by partial adjusted model (Ozeekin and Flannery, 2012). We use Basel III dummy to indicate the implement of the regulation. It equals to 1 after year 2009, and 0 otherwise. Control Variables include: 1) bank size, 2) capital ratio, 3) diversification, 4) local market power, 5) ROA, 6) non-performing loans, 7) off balance sheet activities, 8) loan loss provisions, 9) real GDP growth, 10) inflation rate. Variables definitions are provided in Appendix B.

Variable	Mean	SD	25%	50%	75%
Dependent Variables					
Delta CoVaR	3.48	3.24	1.34	2.55	4.50
SES	1.92	3.24	1.65	1.97	4.50
Regulation Dummy					
Basel III Dummy	0.13	0.33	0.00	0.00	0.00
Liquidity Regressors					
Adjusted Speed of Liquidity Creation	0.21	0.26	0.09	0.14	0.25
Adjusted Speed of NSFR	0.25	0.18	0.18	0.28	0.33
Control Variables					
Bank Size	13.09	1.77	11.88	12.89	14.03
Capital Ratio	0.11	0.11	0.08	0.09	0.11
Diversification Ratio	0.59	3.36	0.08	0.13	0.21
Local Market Power	0.04	0.02	0.03	0.04	0.06
ROA	0.01	0.06	0.01	0.01	0.01
Non-Performing Loans	0.37	1.87	0.00	0.81	1.12
Off Balance Sheet Activities	0.27	1.01	0.09	0.95	1.26
Loan Loss Provisions	22.45	0.74	8.82	14.79	29.25
Real GDP Growth Rate	2.85	1.79	1.79	3.35	4.45
Inflation Rate	1.97	0.66	1.53	1.96	2.28
Observations	15455				

Table 2 The Impact of Adjusted Speed of Liquidity on Systemic Risk

This table shows the results of our baseline model with fixed effects during 1997 to 2012, which is the estimation of impact of adjusted speed of liquidity indicator including liquidity creation (measured by the amount of securitized assets divided by total assets) and inverse of net stable funding ratio (NSFR) on systemic risk measurements including delta CoVaR (Adrian and Brunnermeier, 2008) and SES (Acharya et al., 2010). Delta CoVaR is the difference between the CoVaR conditional on a bank being in distress and the CoVaR conditional on a bank operating in its median state, while SES is the expected amount that a bank is undercapitalized in a systemic event in which the entire financial system is undercapitalized. We measure individual bank's reaction to Basel regulation using "adjusted speed of liquidity", estimated by partial adjusted model (Ozeekin and Flannery, 2012). Adjusted speed measures the speed of individuals to adjust their liquidity according to Basel regulation. We use Basel III dummy to indicate the implement of the regulation. It equals to 1 after year 2009, and 0 otherwise. Control Variables include: 1) bank size, 2) capital ratio, 3) diversification, 4) local market power, 5) ROA, 6) non-performing loans, 7) off balance sheet activities, 8) loan loss provisions, 9) real GDP growth, 10) inflation rate. Variables definitions are provided in Appendix B. We also provide information about whether the model contains controls for bank and time fixed effect. To deal with the possible time series issue, all the control variables have been lagged for one year. T-statistics are based on standard errors clustered at the bank level, where *, **, *** denote statistical significance at the 10%, 5%, and 1% levels respectively.

Dependent Variable	Delta CoVaR		SES	
Liquidity Indicator	Liquidity Creation		NSFR	
Adjusted Speed of Liquidity Indicator	0.646	-0.679	0.108*	-0.0450
	(0.38)	(0.59)	(0.05)	(0.08)
Basel III Dummy	-1.309***	-1.245***	-0.295***	-0.219***
	(0.29)	(0.36)	(0.04)	(0.05)
Adjusted Speed * Basel III	-0.683***	-0.669***	-0.246***	-0.413***
	(0.36)	(0.74)	(0.05)	(0.10)
Bank Size	0.191***	0.188***	0.0523***	0.0510***
	(0.08)	(0.08)	(0.01)	(0.01)
Capital Ratio	2.112***	2.162***	0.553***	0.553***
	(0.78)	(0.78)	(0.10)	(0.11)
Diversification Ratio	0.558	0.582	0.108	0.120
	(0.00)	(0.00)	(0.00)	(0.00)
Local Market Power	-9.348**	-9.269**	-1.423**	-1.409**
	(3.23)	(3.23)	(0.44)	(0.44)
ROA	0.946	0.950	0.110	0.110
	(0.59)	(0.59)	(0.08)	(0.08)
Non-Performing Loans	0.212**	0.213**	0.518**	0.519**
	(0.00)	(0.00)	(0.00)	(0.00)
Off Balance Sheet Activities	0.575	0.563	0.109	0.108
	(0.00)	(0.00)	(0.00)	(0.00)
Loan Loss Provisions	-0.149***	-0.149***	-0.314***	-0.322***
	(0.00)	(0.00)	(0.00)	(0.00)
Real GDP Growth Rate	0.065***	0.063***	0.018***	0.017***
	(0.03)	(0.03)	(0.00)	(0.00)
Inflation Rate	0.124*	0.129*	0.023*	0.024*
	(0.08)	(0.08)	(0.01)	(0.01)
Constant	0.943***	1.289***	1.205***	1.258***
	(0.98)	(0.98)	(0.13)	(0.13)
Bank Fixed Effect	Yes	Yes	Yes	Yes
Time Fixed Effect	Yes	Yes	Yes	Yes
Observations	13043	13043	13043	13043
Adjusted R-squared	0.0914	0.0918	0.0326	0.0317

Table 3: Panel A Determinants of Banks' Propensity Scores

This table presents the probit regression estimates of the propensity to provide high liquidity adjusted speed. The dependent variable equals to one for banks with high liquidity adjusted speed (the value higher than average) and zero otherwise. We use two liquidity adjusted speeds representing the two indicators, liquidity creation and net stable fund ratio. All explanatory variables are lagged one year. The reported standard errors are clustered at the bank level. *, **, *** stand for statistical significance at the 10%, 5%, and 1% levels, respectively.

	High Liquidity Adjusted Speed Dummy	
Liquidity Creation	-1.000***	0.172***
	(0.14)	(0.10)
Bank Size	-0.065***	-0.069***
	(0.01)	(0.01)
Capital Ratio	-0.680***	-0.674***
	(0.12)	(0.12)
Diversification Ratio	0.149*	0.139*
	(0.00)	(0.00)
Local Market Power	5.986***	5.564***
	(0.56)	(0.58)
ROA	-1.665***	-1.644***
	(0.34)	(0.34)
Non-Performing Loans	-0.877	-0.101
	(0.00)	(0.00)
Off Balance Sheet Activities	1.259***	1.339***
	(0.00)	(0.00)
Loan Loss Provisions	-8.298	-7.318
	(0.00)	(0.00)
Constant	0.267**	-0.041***
	(0.10)	(0.07)
Year Dummies	Yes	Yes
Log Likelihood	-9290.2551	-9316.2232
Observations	15453	15453

Table 3: Panel B Additional Analysis 1: Propensity Score Matching by Liquidity Level

This table shows additional analysis 1 concerning whether adjusted speeds of liquidity indicators matter to systemic measurements compared with liquidity level. Systemic risk measurements including delta CoVaR (Adrian and Brunnermeier, 2008) and SES (Acharya et al., 2010). Delta CoVaR is the difference between the CoVaR conditional on a bank being in distress and the CoVaR conditional on a bank operating in its median state, while SES is the expected amount that a bank is undercapitalized in a systemic event in which the entire financial system is undercapitalized. We use propensity score matching method to match similar liquidity levels between low and high liquidity adjusted speeds individuals. Liquidity indicators include liquidity creation (measured by the amount of securitized assets divided by total assets) and inverse of net stable funding ratio (NSFR). High speed individuals are those banks with adjusted speeds higher than average, while low individuals are those ones lower than average. We match two groups of banks by liquidity creation or NSFR, and related bank specific variables. Variables definitions are provided in Appendix B. Information of observations, treated and untreated values of systemic risk measurements and the differences are presented in the table.

A: Matching by liquidity creation level				
	Observations	Treated	Untreated	Difference
Delta CoVaR	4642	3.022	3.618	-0.596***
SES	4642	1.823	1.950	-0.126***
B: Matching by NSFR level				
	Observations	Treated	Untreated	Difference
Delta CoVaR	3828	2.991	3.382	-0.391***
SES	3828	1.813	1.887	-0.073***

Table 4 The Impact of Liquidity Indicators on Systemic Risk

This table shows the results of our additional analysis 3 with fixed effects during 1997 to 2012, which is the estimation of impact of liquidity indicators including liquidity creation (measured by the amount of securitized assets divided by total assets) and inverse of net stable funding ratio (NSFR) on systemic risk measurements including delta CoVaR (Adrian and Brunnermeier, 2008) and SES (Acharya et al., 2010). Delta CoVaR is the difference between the CoVaR conditional on a bank being in distress and the CoVaR conditional on a bank operating in its median state, while SES is the expected amount that a bank is undercapitalized in a systemic event in which the entire financial system is undercapitalized. We use Basel III dummy to indicate the implement of the regulation. It equals to 1 after year 2009, and 0 otherwise. Control Variables include: 1) bank size, 2) capital ratio, 3) diversification, 4) local market power, 5) ROA, 6) non-performing loans, 7) off balance sheet activities, 8) loan loss provisions, 9) real GDP growth, 10) inflation rate. Variables definitions are provided in Appendix B. We also provide information about whether the model contains controls for bank and time fixed effect. To deal with the possible time series issue, all the control variables have been lagged for one year. T-statistics are based on standard errors clustered at the bank level, where *, **, *** denote statistical significance at the 10%, 5%, and 1% levels respectively.

Dependent Variable	Delta CoVaR		SES	
Liquidity Indicator	Liquidity Creation		NSFR	
Liquidity Indicators	0.621	0.209	0.336	0.523
	(0.76)	(0.31)	(0.10)	(0.04)
Basel III Dummy	-1.233***	-1.361***	-0.411***	-0.353***
	(0.33)	(0.29)	(0.05)	(0.04)
Liquidity Indicators * Basel III	1.593	0.528	0.274	0.419
	(1.21)	(0.68)	(0.17)	(0.09)
Bank Size	0.190***	0.184***	0.051***	0.051***
	(0.08)	(0.08)	(0.01)	(0.01)
Capital Ratio	2.152**	2.115**	0.551***	0.549***
	(0.78)	(0.78)	(0.10)	(0.11)
Diversification Ratio	63.867	59.129	10.918	11.728
	(0.00)	(0.00)	(0.00)	(0.00)
Local Market Power	-9.201**	-9.425**	-1.419**	-1.398**
	(3.23)	(3.24)	(0.44)	(0.44)
ROA	0.970	0.958	0.116	0.109
	(0.59)	(0.59)	(0.08)	(0.08)
Non-Performing Loans	0.222**	0.219**	0.524**	0.527**
	(0.00)	(0.00)	(0.00)	(0.00)
Off Balance Sheet Activities	0.575	0.562	0.113	0.106
	(0.00)	(0.00)	(0.00)	(0.00)
Loan Loss Provisions	-0.157**	-0.152**	-0.308**	-0.310**
	(0.00)	(0.00)	(0.00)	(0.00)
Real GDP Growth Rate	0.054	0.115*	0.024***	0.014
	(0.04)	(0.06)	(0.00)	(0.01)
Inflation Rate	0.122**	0.156**	0.029**	0.023*
	(0.08)	(0.08)	(0.01)	(0.01)
Constant	1.068***	0.905***	1.180***	1.267***
	(0.98)	(1.00)	(0.13)	(0.14)
Bank Fixed Effect	Yes	Yes	Yes	Yes
Time Fixed Effect	Yes	Yes	Yes	Yes
Observations	13093	13093	13043	13043
Adjusted R-squared	0.0918	0.0919	0.0318	0.0303

Table 5A The Impact of Adjusted Speed of Liquidity Indicators on Systemic Measurements among Small Banks

This table shows the additional analysis results with fixed effects during 1997 to 2012, which is the estimation of impact of adjusted speed of liquidity indicator including liquidity creation (measured by the amount of securitized assets divided by total assets) and inverse of net stable funding ratio (NSFR) on systemic risk measurements including delta CoVaR (Adrian and Brunnermeier, 2008) and SES (Acharya et al., 2010), among banks with different sizes. Small banks are those banks have a total asset less than $3 billion, medium banks are those banks with total assets between $3 billion and $10 billion, and large banks are those have total assets more than $10 billion. Results are reported in Table 4A, 4B, and 4C, respectively. Delta CoVaR is the difference between the CoVaR conditional on a bank being in distress and the CoVaR conditional on a bank operating in its median state, while SES is the expected amount that a bank is undercapitalized in a systemic event in which the entire financial system is undercapitalized. We measure individual bank's reaction to Basel regulation using "adjusted speed of liquidity", estimated by partial adjusted model (Ozeekin and Flannery, 2012). Adjusted speed measures the speed of individuals to adjust their liquidity according to Basel regulation. We use Basel III dummy to indicate the implement of the regulation. It equals to 1 after year 2009, and 0 otherwise. Control Variables include: 1) bank size, 2) capital ratio, 3) diversification, 4) local market power, 5) ROA, 6) non-performing loans, 7) off balance sheet activities, 8) loan loss provisions, 9) real GDP growth, 10) inflation rate. Variables definitions are provided in Appendix B. We also provide information about whether the model contains controls for bank and time fixed effect. To deal with the possible time series issue, all the control variables have been lagged for one year. T-statistics are based on standard errors clustered at the bank level, where *, **, *** denote statistical significance at the 10%, 5%, and 1% levels respectively.

Dependent Variable	Delta CoVaR		SES	
Liquidity Indicator	Liquidity Creation		NSFR	
Adjusted Speed of Liquidity Indicator	0.578	-0.950	0.0416	-0.0348
	(0.41)	(0.75)	(0.05)	(0.10)
Basel III Dummy	-1.852***	-1.793***	-0.273***	-0.175***
	(0.35)	(0.42)	(0.04)	(0.05)
Adjusted Speed * Basel III	-0.596***	-0.615***	-0.232***	-0.464***
	(0.40)	(0.82)	(0.05)	(0.11)
Bank Size	0.428***	0.425***	0.115***	0.113***
	(0.10)	(0.10)	(0.01)	(0.01)
Capital Ratio	2.705**	2.743**	0.635***	0.626***
	(0.89)	(0.89)	(0.12)	(0.12)
Diversification Ratio	23.521	24.638	6.037	7.133
	(0.00)	(0.00)	(0.00)	(0.00)
Local Market Power	-8.571*	-8.554*	-1.049*	-1.053*
	(3.48)	(3.48)	(0.46)	(0.46)
ROA	0.660	0.660	0.601	0.398
	(0.60)	(0.60)	(0.08)	(0.08)
Non-Performing Loans	-6.164**	-6.184**	-5.266**	-5.473**
	(0.00)	(0.00)	(0.00)	(0.00)
Off Balance Sheet Activities	0.131	0.134	-0.024	-0.028
	(0.00)	(0.00)	(0.00)	(0.00)
Loan Loss Provisions	-33.326***	-33.939***	-12.106***	-12.217***
	(0.00)	(0.00)	(0.00)	(0.00)
Real GDP Growth Rate	-0.041*	-0.044*	0.011*	0.010*
	(0.07)	(0.07)	(0.00)	(0.00)
Inflation Rate	-0.013	-0.009	0.002	0.004
	(0.07)	(0.07)	(0.01)	(0.01)
Constant	-1.242	-0.824	0.527***	0.572***
	(1.25)	(1.25)	(0.16)	(0.16)
Bank Fixed Effect	Yes	Yes	Yes	Yes
Time Fixed Effect	Yes	Yes	Yes	Yes
Observations	11180	11180	11136	11136
Adjusted R-squared	0.1079	0.1081	0.0441	0.0440

Table 5B The Impact of Adjusted Speed of Liquidity Indicators on Systemic Measurements among Medium Banks

Dependent Variable	Delta CoVaR		SES	
Liquidity Indicator	Liquidity Creation		NSFR	
Adjusted Speed of Liquidity Indicator	0.691	-1.446	0.260	-0.446
	(1.26)	(1.61)	(0.20)	(0.25)
Basel III Dummy	-3.832***	-3.712***	-1.228***	-1.125***
	(0.35)	(0.42)	(0.04)	(0.05)
Adjusted Speed * Basel III	-0.261	-0.582	-0.159	0.431
	(1.68)	(2.78)	(0.27)	(0.44)
Bank Size	-0.330***	-0.319***	-0.067***	-0.065***
	(0.33)	(0.33)	(0.05)	(0.05)
Capital Ratio	-7.366***	-7.480***	-0.785***	-0.791***
	(5.04)	(5.04)	(0.80)	(0.80)
Diversification Ratio	0.021	0.018	0.040	0.040
	(0.22)	(0.22)	(0.03)	(0.03)
Local Market Power	-3.630	-3.367	-1.263	-1.254
	(10.17)	(10.13)	(1.62)	(1.61)
ROA	3.658	3.382	5.323*	5.179*
	(13.41)	(13.41)	(2.17)	(2.17)
Non-Performing Loans	3.912***	3.993***	1.401***	1.238***
	(0.00)	(0.00)	(0.00)	(0.00)
Off Balance Sheet Activities	-0.688	-0.856	0.586	0.548
	(0.00)	(0.00)	(0.00)	(0.00)
Loan Loss Provisions	-3.072***	-3.139***	-0.979***	-0.974***
	(0.00)	(0.00)	(0.00)	(0.00)
Real GDP Growth Rate	0.030	0.013	0.019	0.040
	(0.13)	(0.17)	(0.02)	(0.03)
Inflation Rate	0.578*	0.566*	0.078*	0.089*
	(0.25)	(0.26)	(0.04)	(0.04)
Constant	7.969	8.370	2.807***	2.810***
	(5.15)	(5.16)	(0.82)	(0.82)
Bank Fixed Effect	Yes	Yes	Yes	Yes
Time Fixed Effect	Yes	Yes	Yes	Yes
Observations	1059	1059	1055	1055
Adjusted R-squared	0.1590	0.1582	0.0724	0.0747

Table 5C. The Impact of Adjusted Speed of Liquidity Indicators on Systemic Measurements among Large Banks

Dependent Variable	Delta CoVaR		SES	
Liquidity Indicator	Liquidity Creation		NSFR	
Adjusted Speed of Liquidity Indicator	-1.438	0.033	-0.037	-0.028
	(1.77)	(1.21)	(0.24)	(0.16)
Basel III Dummy	-2.232***	-2.212***	-0.628***	-0.725***
	(0.35)	(0.42)	(0.04)	(0.05)
Adjusted Speed * Basel III	-2.878	-1.082	-0.362	-0.095
	(2.08)	(2.64)	(0.28)	(0.35)
Bank Size	0.285	0.211	0.070	0.055
	(0.30)	(0.29)	(0.04)	(0.04)
Capital Ratio	-1.447***	-0.277***	0.501***	0.733***
	(4.01)	(4.00)	(0.54)	(0.53)
Diversification Ratio	1.973***	1.628***	0.636***	0.555***
	(0.00)	(0.00)	(0.00)	(0.00)
Local Market Power	-36.39	-36.23	-2.573	-2.560
	(25.16)	(25.19)	(3.36)	(3.36)
ROA	16.072***	13.947***	5.875***	5.349***
	(14.63)	(14.54)	(1.95)	(1.94)
Non-Performing Loans	0.135***	0.135***	0.029***	0.029***
	(0.00)	(0.00)	(0.00)	(0.00)
Off Balance Sheet Activities	0.423***	0.438***	0.095***	0.098***
	(0.00)	(0.00)	(0.00)	(0.00)
Loan Loss Provisions	-45.512	-39.205	-7.283	-8.516
	(0.00)	(0.00)	(0.00)	(0.00)
Real GDP Growth Rate	0.124	0.119	0.074*	0.062
	(0.25)	(0.27)	(0.03)	(0.04)
Inflation Rate	0.765	0.774	0.024	0.023
	(0.40)	(0.40)	(0.05)	(0.05)
Constant	-1.355	-0.378	0.466	0.746
	(5.21)	(4.97)	(0.70)	(0.66)
Bank Fixed Effect	Yes	Yes	Yes	Yes
Time Fixed Effect	Yes	Yes	Yes	Yes
Observations	854	854	852	852
Adjusted R-squared	0.0267	0.0293	0.1450	0.1425