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The relationship between liquidity risk and credit risk in banks

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ABSTRACT

This paper investigates the relationship between the two major sources of bank default risk: liquidity risk and credit risk. We use a sample of virtually all US commercial banks during the period 1998–2010 to analyze the relationship between these two risk sources on the bank institutional-level and how this relationship influences banks' probabilities of default (PD). Our results show that both risk categories do not have an economically meaningful reciprocal contemporaneous or time-lagged relationship. However, they do influence banks' probability of default. This effect is twofold: whereas both risks separately increase the PD, the influence of their interaction depends on the overall level of bank risk and can either aggravate or mitigate default risk. These results provide new insights into the understanding of bank risk and serve as an underpinning for recent regulatory efforts aimed at strengthening banks (joint) risk management of liquidity and credit risks.

1. Introduction

What is the relationship between liquidity risk and credit risk in financial institutions? Classic theories of the microeconomics of banking support the view that liquidity risk and credit risk are closely linked. Both industrial organization models of banking, such as the Monti–Klein framework, and the financial intermediation perspective in a Bryant (1980) or Diamond and Dybvig (1983) setting, suggest that a bank's asset and liability structures are closely connected, especially with regard to borrower defaults and fund withdrawals. This does not only hold true for banks' balance sheet business but also for the lending and funding business conducted through off-balance sheet items, as shown by e.g. Holmström and Tirole (1998) or Kashyap et al. (2002). Building on these models, a body of literature has recently evolved focusing on the interaction of liquidity risk and credit risk and the implications for bank stability. Papers such as Goldstein and Pauzner (2005), Wagner (2007), Cai and Thakor (2008), Gatev et al. (2009), Acharya et al. (2010), Acharya and Viswanathan (2011), Gorton and Metrick (2011), He and Xiong (2012a,b), and Acharya and Mora (in press) look into the matter from various angles and derive, mostly from a theoretical perspective, results which show the influence liquidity and credit risk have on each other and also how this interaction influences bank stability.

Anecdotal evidence from bank failures during the recent financial crisis further supports these theoretical and empirical results. Perhaps only indicative in nature, official reports of the FDIC and OCC about the reasons for bank failures (so called "Material Loss Reports"[1]) explicitly state that the majority of commercial bank failures during the recent crisis were partly caused by the joint occurrence of liquidity risks and credit risks. Also, Switzerland-based money center bank UBS addressed the main causes for its substantial losses and subsequent financial distress in the wake of the 2007/2008 financial crisis in a 2008 report to its shareholders[2] as follows: "UBS funding framework and related approach to balance sheet management were significant contributors to the creation of UBS's Subprime exposure" (p. 36). Apparently, the bank did not differentiate between liquid and illiquid assets and the respective term funding and thereby also disregarded the credit risks of the assets. Albeit this evidence is only of anecdotal nature, it might be a sign that the joint occurrence of liquidity and credit risks plays a tremendous role for banks and their stability, and that banks do not account for this joint occurrence in their risk management systems. This assumption

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[1] Material Loss Reports are published by the FDIC and OCC whenever a bank default results in a "material loss" to the FDIC insurance fund. On January 1st 2010, the threshold for a "material loss" to the FDIC fund was raised from 25 million to 200 million US Dollar. The reports contain a detailed analysis of the failed banks' backgrounds and business models and list the failure reasons.

[2] Shareholder Report on UBS's Write-Downs, UBS AG, Zurich, Switzerland, 04-18-2008, available through http://www.ubs.com/global/en/about_ubs/investor_relations/share_information/shareholderreport.html.

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is supported by recent regulatory changes, like the Basel III framework and its Liquidity Coverage Ratio (LCR) and Net Stable Funding (NSF) Ratio, or the Dodd–Frank Act with its proposed liquidity stress-tests. Yet, in spite of this alleged importance and the ample theoretic evidence behind it, no paper has so far analyzed the relation between liquidity risk and credit risk on a broad range and in its different dimensions across the banking sector. As a consequence, many important questions regarding this topic remain unanswered: what is the general relationship between liquidity risks and credit risks in banks? Do liquidity and credit risk jointly influence banks' probability of default (PD)? If so, do banks manage both risks together?

We try to answer these questions by empirically analyzing the relationship between liquidity risk and credit risk in 4046 non-default and 254 default US commercial banks over the period 1998:Q1 to 2010:Q3, using a large variety of different subsamples and tests. We use two main liquidity and credit risk proxy variables.[3] We develop a liquidity risk (LR) proxy variable which measures short-term funding risks of banks, as represented by the relationship of short-term obligations to short-term assets, including off-balance sheet items as for example unused loan commitments. We thereby account for classic "bank run" risks. For credit risk (CR) we develop a proxy variable measuring the unexpected loan default ratio of a bank, as represented by the net loan losses in the current period to the allowances for these loan losses recorded in the previous period. This variable captures the current riskiness of a banks' loan portfolio and the accuracy of a bank's risk management to anticipate near-term loan losses.

In the first step of our analysis we measure the general relationship between liquidity and credit risk in banks. We are specifically interested in whether or not there is a reciprocal relationship between the two factors, i.e. whether or not liquidity risk influences credit risk or vice versa, and if this relationship is positive or negative. Our results show that there is no reliable relationship between liquidity risk and credit risk in banks. We distinguish between the different dimensions of liquidity and credit risk using several proxy variables and control for other possible influence factors in a large number of robustness tests. Furthermore, we incorporate different econometric approaches: a simultaneous equations model controlling for both contemporaneous and lagged influences between liquidity risk and credit risk, and a panel-VAR model together with a correlation analysis to separately control for contemporaneous and lagged relationships. Although the results in some cases show statistical significances, the economic influence is at best marginal.

Given that there is no reliable relationship between the two risk factors across banks, we ask in the second part of our analysis if liquidity risk and credit risk individually and also jointly contribute to bank default risk. For this purpose we include our main proxy variables for liquidity risk and credit risk, as well as the interaction between both risks in a multivariate logistic regression model to determine their contributions to banks' PD. Our results show that both liquidity risk and credit risk individually influence banks' PD. Furthermore, we find that the interaction between the two risk categories has an additional effect on bank PD. Surprisingly, this effect varies for banks with different levels of PD: the joint occurrence of liquidity and credit risks has a PD-aggravating effect for banks with a PD of 10–30%. In contrast, we find that it is mitigating for banks with a high PD of 70–90%. Apparently, the joint effect of simultaneously high liquidity and credit risk has a dampening effect on the otherwise PD-aggravating individual effects of the two risk categories in banks which are close to default. These results might point to a gambling for resurrection behavior. Taken together, our findings suggest that there is an important relation between liquidity risk and credit risk which affects the overall probability of bank default.

Our study contributes to two strands of literature. For liquidity risk, these are the seminal works of Bryant (1980) and Diamond and Dybvig (1983) which have been extended, refined and applied numerous times by e.g. Calomiris and Kahn (1991), Diamond and Rajan (2001), and most recently Berger and Bouwman (2009).[4] The credit risk studies we build on are too numerous to be mentioned in full; the most recent examples include e.g. Illueca et al. (2008), Laeven and Levine (2009), Foos et al. (2010), Houston et al. (2010), and also Rajan and Winton (1995), Boot (2000), and Berger and Udell (2004) (a very in-depth overview of earlier studies is provided by e.g. Altman and Saunders, 1998). The remainder of the paper is structured as follows. Section 2 provides the theoretical background for our analysis. Section 3 describes the data including our proxy variables for liquidity and credit risk and presents descriptive statistics. Section 4 presents the results and Section 5 concludes.

2. Theoretical background

2.1. The reciprocal relationship between liquidity risk and credit risk

Over the past 50–60 years, a tremendous amount of literature has dealt with banks' liquidity and credit risks. Explanations for the way banks work and their major risk and return sources are given by two major research strands regarding the microeconomics of banking: the classic financial intermediation theory, most prominently represented by the Bryant (1980) and Diamond and Dybvig (1983) models and their extensions (such as Qi, 1994, or Diamond, 1997), and also by the industrial organization approach to banking, which features most prominently in the Monti–Klein model of banking organizations and subsequent related research. The models of both strands of literature suggest that, at least in theory, there is a relationship between liquidity and credit risk. The Monti–Klein framework and its extensions (e.g. Prisman et al., 1986) take borrower defaults and sudden fund withdrawals into account, both assumed to be lowering a bank's profit. Because equity, other debt funding and marketable securities are seen as given, banks maximize their profits by maximizing the spread between deposit and loan rates, given an exogenous main refinancing rate as well as stochastic borrower defaults and fund withdrawals. As liquidity risk is seen as a profit-lowering cost, a loan default increases this liquidity risk because of the lowered cash inflow and depreciations it triggers (following e.g. Dermine, 1986). At least in theory, liquidity risk and credit risk should thus be positively correlated. This assumption is supported by the theoretical financial intermediation literature, as modeled by Bryant (1980) as well as Diamond and Dybvig (1983). Extensions of these models show that risky bank assets together with uncertainty about the economy's liquidity needs spark bank runs based on pure panic (Samartín, 2003; Iyer and Puri, 2012). Based on these models, liquidity and credit risk should be positively related and contribute jointly to bank instability.

The idea of a positive relationship between liquidity and credit risk is supported by a very new body of literature which also focuses on the financial crisis of 2007/2008, such as Diamond and Rajan (2005), Acharya and Viswanathan (2011), Gorton and Metrick (2011) and He and Xiong (2012a). Diamond and Rajan's

[3] We investigate two additional risk measures as robustness checks. These are: the BB measure as developed by Berger and Bouwman (2009) for liquidity risk, and the Z-Score as a measure of overall bank stability, following Roy (1952). A detailed discussion of the measures and the results of their analyses are provided in part 4.1.4 of the paper.

[4] Most recent works on liquidity also include Gatev and Strahan (2006), Carletti et al. (2007), Nyborg and Österberg (2010), and Freixas et al. (2011). An overview over the existing bank liquidity literature is provided by Tirole (2011).