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The Impact of Concurrent Capital and Liquidity Requirements

Lakshmi Balasubramanyan

Abstract: The objective of this paper is to examine the impact of concurrent capital and liquidity constraints. The financial crisis of 2008 prompted Basel III, which addresses both capital and liquidity requirements of banks. In an effort to understand the policy efficacy of Basel III, it is important for us to understand how capital regulation and liquidity requirements interact and impact bank lending. We find that when both capital and liquidity constraints are binding; a rise in money market funds restricts loan supply. When the constraints are non-binding, we find that the desired amount of bank equity falls as cash holdings decline.

About the Author: **Lakshmi Balasubramanyan** was an Assistant Professor of Finance at Indiana State University. She received her Ph.D.in Agricultural, Environmental and Regional Economics with her major fields being Finance and Production Economics from The Pennsylvania State University. Her research interests include bank risk management, credit allocation, banking efficiency and industrial organization of banking. Currently, she is a Research Economist at the Federal Reserve Bank of Cleveland.

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1. Introduction

The banking literature has two strands of theoretical predictions concerning the relationship between capital and liquidity. One theory predicts that more capital in a bank diminishes liquidity creation. According to Gorton and Winton (2000), an increase in bank capital may reduce liquidity creation. When regulators require banks to hold more capital, it simply means that investors at the aggregate level hold more bank equity and fewer deposits in their portfolios. These investors need to be compensated for the liquidity advantage they forego by holding bank equity. As such, capital becomes costly from a social standpoint. In a similar vein, Diamond and Rajan (2000, 2001) find that bank equity holders cannot run on the bank, while bank deposit holders can run on the bank if they perceive the bank to be risky. Thus when bank capital ratios increase, liquidity creation is likely to fall. The second theory predicts that more capital increases the bank's ability to generate liquidity. Bhattacharya and Thakor (1993) discuss that as banks increase their capital holdings, they are in a better position to cushion shocks and hence are in a better position to expand risk and generate more liquidity. In more recent empirical research, Berger and Bouwman (2009) find a different relationship between capital and liquidity creation for small and large banks. Their study shows that the net effect of bank capital is positive and statistically significant for large banks, while this effect is negative and statistically significant for small banks.

The 2007-2008 financial crisis has led banks and regulators to examine both capital and liquidity adequacy concurrently. According to the Basel III proposal (Basel Committee, 2010), the Tier 1 capital requirement will increase from 4% to 6%. Banks will be required to hold a capital conservation buffer of up to 2.5%. Concurrently, banks will be required to fulfill liquidity standards. Banks are expected to satisfy a 30-day liquidity coverage ratio and a long-term net stable funding ratio. In order ensure policy efficacy of Basel III, it is important for us to understand how capital regulation and liquidity requirements interact and impact bank lending.

In this study, we closely adapt the Kopecky and VanHoose (2004) model. However, we incorporate both capital and liquidity requirements simultaneously. Our contribution is to specifically account for highly liquid assets and liabilities in our model in order to incorporate the liquidity requirement into the analysis. We examine the impact of concurrent capital and liquidity requirements. When both capital and liquidity requirements are non-binding, the supply of non-transactions deposits falls as the bank's cash holdings rises. We also find that the supply of bank's equity falls as cash holdings decline. The supply of loans increases as banks hold on to more cash and reserves when capital and liquidity constraints are non-binding. When both capital and liquidity constraints are binding, we find that money market deposits are negatively related to loan supply. When a bank holds more liquid liabilities, it is unable to transform these highly liquid liabilities into long term assets such as loans in a mutually reinforcing capital and liquidity constrained scenario. When capital and liquidity constraints are binding, we find that both constraints impede lending. Our approach is a non-stochastic time-invariant model. However, the outcome of our model is directionally similar to that of De Nicolo Gamba and Luccheta (2011).[1]

[1] De Nicolo et al (2011) find that mild capital requirements increase bank lending. However, when capital requirements become too stringent, it impedes bank efficiency and increases costs. They also find that liquidity requirements impede bank lending and can nullify the benefits of mild capital requirements.

The structure of the paper is as follows: Section 2 presents the model for non-binding capital and liquidity constraints and binding constraints. Section 3 concludes and the Appendix outlines the steps for the solutions of the binding and non-binding cases.

2. Impact of concurrent capital and liquidity constraints

2.1 Model structure

The bank model is given by the following where $\overline{C}$ = cash, R = bank reserves, G =government securities, L = loans, M = money market deposits, D = transactions deposits, T = non-transactions deposits, E = bank equity and C_i = bank resource costs for D, T, E, L, G, M . The required reserve ratio is given by ρ and the loan-based capital requirement is given by θ and the liquidity requirement ratio or cash holdings against money market deposits are given by η . The balance sheet constraint is given by Equation (1) while the reserve requirements are given by Equation (2). The capital requirement is defined by Equation (3) while liquidity holding is given by Equation (4). We allow for the liquidity requirement to be against the money market deposits in order to allow for some form of maturity matching.

Balance Sheet:

$\overline{C} + R + G + L = M + D + T + E$ (1)

Reserve Requirements: $R \geq \rho D$ (2)

Capital Requirements: $E \geq \theta L$ (3)

Liquidity Requirements: $\overline{C} \geq \eta M$ (4)

Securities Cost: $C_G = \frac{g}{2} G^2$ (5)

Transactions Deposit Cost: $C_D = \frac{a}{2}D^2$ (6)

Equity Cost: $C_E = \frac{b}{2}E^2$ (7)

Non-transactions deposit cost: $C_T = \frac{c}{2}T^2$ (8)

Loan cost: $C_L = \frac{f}{2}L^2$ (9)

Money market cost: $C_M = \frac{m}{2}M^2$ (10)

We assume a quadratic cost structure for the items G, L, M, D, T, E of the balance sheet. Following Kopecky and VanHoose (2004) closely, we substitute the reserve requirement and liquidity constraint into Equation (1).[2] We obtain the semi-reduced form expression for loan supply:

$$L = R\left(\frac{1-\rho}{\rho}\right) + \overline{C}\left(\frac{1-\eta}{\eta}\right) + T + E + G \qquad (11)$$

$$L = R\hat{\rho} + \overline{C}\hat{\eta} + T + E - G \qquad (12)$$

In this semi-reduced form expression, a banking system's loan capacity depends on reserves, non-transaction deposits, equity, securities and money market funds. Based on the cost functions of (5) to (10), the bank's profit function is given by:

$$\prod = r_L L + r_G G - r_E E - r_T T - r_D D - r_M M - \frac{a}{2}D^2 - \frac{b}{2}E^2 - \frac{c}{2}T^2 - \frac{f}{2}L^2 - \frac{g}{2}G^2 - \frac{m}{2}M^2$$
(13)

[2] Here $D = \frac{R}{\rho}$ and $M = \frac{\overline{C}}{\eta}$ are substituted into the expression $L = D + T + E + M - C - R - G$.

where r_L = loan rate, r_G = securities rate, r_T = non-transactions deposit rate, r_E = return on equity, r_D = transaction deposit rate, r_M = money market rate.[3]

2.2 Solutions to model without binding capital and liquidity constraints

We start off by presenting the solutions for the case where both capital and liquidity constraints are non-binding. When capital and liquidity constraints are non-binding, it implies that $\frac{E}{L} > \theta$ and $\frac{\bar{C}}{M} > \eta$. The bank functions for non-transactions deposits, bank equity, government securities and loan is given by the following:

$$T^* = \frac{\left[\left(f\left(2f\left(r_E - r_G\right) + g\left(r_E - r_T\right)\right) - b\left(\bar{C}\hat{\eta}f\left(2f + g\right) + 2f^2R\hat{\rho} + f\left(r_G + gR\hat{\rho} - 2r_L + r_T\right) + g\left(-r_L + r_T\right)\right)\right)\right]}{\left[\left(cfg + b\left(c\left(f + g\right) + f\left(2f + g\right)\right)\right)\right]} \quad (14)$$

$$E^* = \frac{\left[\left(-c\left(\bar{C}\hat{\eta}fg + f\left(r_E - r_G + gR\hat{\rho}\right) + g\left(r_E - r_L\right)\right) + f\left(-2fr_E - gr_E + 2fr_G + gr_T\right)\right)\right]}{\left[\left(cfg + b\left(c\left(f + g\right) + f\left(2f + g\right)\right)\right)\right]} \quad (15)$$

$$G^* = \frac{\left[\left(cf\left(-r_E + r_G\right) + b\left(c\left(\bar{C}\hat{\eta}f + r_G + fR\hat{\rho} - r_L\right) + f\left(r_G - r_T\right)\right)\right)\right]}{\left[\left(cfg + b\left(c\left(f + g\right) + f\left(2f + g\right)\right)\right)\right]} \quad (16)$$

$$L^* = \frac{\left[cg\left(-r_E + r_L\right) + b\left(-2fr_G + 2fr_L + gr_L + c\left(\bar{C}\hat{\eta}g - r_G + gR\hat{\rho} + r_L\right) - gr_T\right)\right]}{\left[\left(cfg + b\left(c\left(f + g\right) + f\left(2f + g\right)\right)\right)\right]} \quad (17)$$

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[3] We substitute Equation (13) into the profit function (13) and our final profit function is given by:

$$\Pi = r_L\left(R\hat{\rho} + \bar{C}\hat{\eta} + T + E - G\right) + r_G G - r_E E - r_T T - r_D D - r_M M$$

$$-\frac{a}{2}D^2 - \frac{b}{2}E^2 - \frac{c}{2}T^2 - \frac{f}{2}\left(R\hat{\rho} + \bar{C}\hat{\eta} + T + E + G\right)^2 - \frac{g}{2}G^2 - \frac{m}{2}M^2$$

In all of the solutions, we take $f > 0$. The supply of non-transactions deposits (T) declines as the bank's cash holdings ($\bar{C}$) increases. We also find that the supply of bank's equity (E) falls as cash holdings decline. However, the supply of loans increases as banks hold on to more cash and reserves when capital and liquidity constraints are non-binding.

2.3 Solutions to model with binding capital and liquidity constraints

In this section, we present the solutions to the case where both capital and liquidity constraints are imposed. The 2008 financial crisis presented a scenario in which both capital and liquidity requirements would have been triggered simultaneously. Here $\frac{E}{L} \leq \theta$ and $\frac{\bar{C}}{M} \leq \eta$ and we derive the optimal values of T^{**}, G^{**} and L^{**}.

$$E^{**} = \theta L \qquad (18)$$

$$\bar{C}^{**} = \eta M \qquad (19)$$

$$T^{**} = \frac{\left[\left(-g\left(r_L + r_T\left(-1+\theta\right)\right)\left(-1+\theta\right)^2 + f\left(r_T + r_G\left(-1+\theta\right)\right) + g\left(\left(-1+\eta\right)M - R\hat{\rho}\right)\left(-1+\theta\right) + r_L\theta - 2r_T\theta + r_T\theta^2\right)\right]}{\left[\left(f^2 - f\left(1+c\left(-1+\theta\right)^2\right) + g\left(1+c\left(-1+\theta\right)^2\right)\left(-1+\theta\right)\right)\right]}$$

(20)

$$G^{**} = \frac{\left[\left(\begin{array}{l} f^2\left(M - \eta M + R\hat{\rho}\right) + f\left(\left(-1+\eta\right)M\left(1+c\left(-1+\theta\right)^2\right) - R\hat{\rho}\left(1+c\left(-1+\theta\right)^2\right) + \left(r_L + r_T\left(-1+\theta\right)\right)\left(-1+\theta\right)\right) \\ +\left(r_L + r_G\left(-1+\theta\right)\right)\left(1+c\left(-1+\theta\right)^2\right) \end{array}\right)\right]}{\left[\left(f^2 - f\left(1+c\left(-1+\theta\right)^2\right) + g\left(1+c\left(-1+\theta\right)^2\right)\left(-1+\theta\right)\right)\right]}$$

(21)

$$L^{**}=\frac{\begin{bmatrix}(r_L+r_G(-1+\theta))(1-f+c(-1+\theta)^2)+g((-1+\eta)M(1-f+c(-1+\theta)^2)-R\hat{\rho}(1-f+c(-1+\theta)^2)\\+(r_L+r_T(-1+\theta))(-1+\theta))(-1+\theta)\end{bmatrix}}{\left[(f^2-f(1+c(-1+\theta)^2)+g(1+c(-1+\theta)^2)(-1+\theta))(1-\theta)\right]} \quad (22)$$

Since $0<\eta<1$, the money market funds (M) are negatively related to loan supply. When a bank holds more liquid liabilities, it is unable to transform these highly liquid liabilities into long term assets such as loans. When capital and liquidity constraints are binding, we find that both constraints impede lending. This finding is consistent with De Nicolo et al (2011).

3. Conclusion

The objective of this paper is to examine the impact of concurrent capital and liquidity constraints. The financial crisis of 2008 prompted Basel III, which addresses both capital and liquidity requirements of banks. In an effort to understand the policy efficacy of Basel III, it is important for us to understand how capital regulation and liquidity requirements interact and impact bank lending. We find that when both capital and liquidity constraints are binding; a rise in money market funds restricts loan supply. When the constraints are non-binding, we find that the desired amount of bank equity falls as cash holdings decline.

As this model falls within a non-stochastic framework, it does not capture the dynamic process of liability-asset transformation and how liquidity mismatches are resolved. This aspect of dynamic modeling is left for future research.

Appendix

Non-binding capital and liquidity constraints

$$\Pi = r_L \left(R\hat{\rho} + \overline{C}\hat{\eta} + T + E - G \right) + r_G G - r_E E - r_T T - r_D D - r_M M$$
$$-\frac{a}{2}D^2 - \frac{b}{2}E^2 - \frac{c}{2}T^2 - \frac{f}{2}\left(R\hat{\rho} + \overline{C}\hat{\eta} + T + E + G \right)^2 - \frac{g}{2}G^2 - \frac{m}{2}M^2 \qquad (23)$$

$$\frac{\partial \Pi}{\partial T} = (c + f)T + fE + fG = r_L - r_T - f\hat{\rho}R - f\overline{C}\hat{\eta} \qquad (24)$$

$$\frac{\partial \Pi}{\partial E} = fT + (f + b)E - fG = r_L - r_E - fR\hat{\rho} - f\overline{C}\hat{\eta} \qquad (25)$$

$$\frac{\partial \Pi}{\partial G} = -fT - fE + (g + f)G = r_G - r_L + fR\hat{\rho} + f\overline{C}\hat{\eta} \qquad (26)$$

We solve for T*, E* and G*.

$$\begin{bmatrix} (c+f) & f & f \\ f & (f+b) & -f \\ -f & -f & (g+f) \end{bmatrix} \begin{bmatrix} T \\ E \\ G \end{bmatrix} = \begin{bmatrix} r_L - r_T - f\hat{\rho}R - f\overline{C}\hat{\eta} \\ r_L - r_E - fR\hat{\rho} - f\overline{C}\hat{\eta} \\ r_G - r_L + fR\hat{\rho} + f\overline{C}\hat{\eta} \end{bmatrix} \qquad (27)$$

We substitute optimal T*, E* and G* into (28) to obtain the solutions for Equations (14) to (17):

$$L^* = R\hat{\rho} + \overline{C}\hat{\eta} + T^* + E^* - G^* \qquad (28)$$

Binding capital and liquidity constraints

When capital and liquidity constraints are binding, $E = \theta L$ and $\overline{C} = \eta M$

$$\begin{aligned} L &= R\hat{\rho} + \overline{C}\hat{\eta} + T + E + G \\ &= R\hat{\rho} + (\eta M)\hat{\eta} + T + (\theta E) - G \quad (29) \\ &= \frac{R\hat{\rho} + \eta M\hat{\eta} + T - G}{1 - \theta} \end{aligned}$$

The profit function is now given by[4]:

$$\Pi = r_L\left[\frac{R\hat{\rho}+\eta\hat{\eta}+T-G}{1-\theta}\right]+r_G G-r_E E-r_T T-r_D D-r_M M$$
$$-\frac{a}{2}D^2-\frac{b}{2}E^2-\frac{c}{2}T^2-\frac{f}{2}\left[\frac{R\hat{\rho}+\eta\hat{\eta}+T-G}{1-\theta}\right]^2-\frac{g}{2}G^2-\frac{m}{2}M^2 \qquad (30)$$

$$\frac{\partial\Pi}{\partial T} = -\left(c+\frac{1}{(1-\theta)^2}\right)T+\frac{f}{(1-\theta)^2}G = \frac{f(1-\eta)M+fR\hat{\rho}-r_L(1-\theta)}{(1-\theta)^2}+r_T \qquad (31)$$

$$\frac{\partial\Pi}{\partial G} = \frac{f}{(1-\theta)}T-\left[\frac{f}{1-\theta}+g\right]G = \frac{r_L-fR\hat{\rho}-f(1-\eta)M}{(1-\theta)}-r_G \qquad (32)$$

We solve for T** and G**

$$\begin{bmatrix} -\left(c+\frac{1}{(1-\theta)^2}\right) & \frac{f}{(1-\theta)^2} \\ \frac{f}{1-\theta} & -\left(\frac{f}{1-\theta}+g\right) \end{bmatrix}\begin{bmatrix} T \\ G \end{bmatrix} = \begin{bmatrix} \frac{f(1-\eta)M+fR\hat{\rho}-r_L(1-\theta)}{(1-\theta)^2}+r_T \\ \frac{r_L-fR\hat{\rho}-f(1-\eta)M}{(1-\theta)}-r_G \end{bmatrix} \qquad (33)$$

We substitute optimal T** and G** into Equation (34) to obtain the solutions for Equations (20) to (21):

$$L^{**} = \frac{R\hat{\rho}+\eta M\hat{\eta}+T^{**}-G^{**}}{1-\theta} \qquad (34)$$

[4] Note that $\hat{\eta} = \frac{1-\eta}{\eta}$

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