The versatility of money multiplier under Basel III regulations

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ABSTRACT
The fractional reserve theory of money creation only considers the reserve requirement but ignores prudential regulations. We study the impacts of three prudential regulations under the Basel III framework on the commercial bank's ability to create money. Using a balance sheet approach, we formulate the corresponding maximum money multiplier under each regulation. We find that in addition to the concerned minimum required ratio, the banking system's liquidity and equity positions also play important roles in determining the maximum money supply.

KEYWORDS
prudential regulations; money creation; balance sheet approach; liquidity and equity position; money multiplier

JEL CLASSIFICATION
E51; G28; G18; E60

1. Introduction

Recent financial crises have reignited heated discussions about the role of banks in money creation (Werner 2014; Ábel, Lehmann, and Tapaszti 2016; Keen 2010). The textbook model of money creation is the fractional reserve theory (FRT). In this theory, individual banks are financial intermediaries between depositors and debtors and their lending ability is constrained by their deposits and the reserve requirement. Because the required quantity of reserves is a fraction of the total deposits, the banking system as whole can magnify the monetary base by a constant money multiplier, which is usually expressed as the inverse of the required reserve ratio in its simplest form.

Despite the wide acceptance of the FRT, there is growing consensus that commercial banks are not simply intermediators of money, but are creators of credit (Werner 2014). According to the official bulletin of the Bank of England (McLeay, Radia, and Thomas 2014), commercial banks making loans is the principal means of creating money in the modern economy. Whenever a bank makes a loan, it simultaneously creates a matching deposit in the borrower's bank account. Each individual bank does not pass on deposits or reserves into its lending but creates loans out of nothing. Thus bank lending is not determined by pre-existing amount of deposits or reserves, but depends

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on the profitability of this loan and the banking regulations to which the bank is subject (Goodhart 2010).

Among the concerned regulations faced by commercial banks, we argue that the reserve requirement policy has become a less important constraint while prudential regulations affect bank's credit supply in a much more targeted fashion. Many advanced economies do not have reserve requirement, such as the UK, Canada and Australia. Regardless, for countries that do retain this policy, banks can always make loans first and fulfill the reserve requirement later by borrowing from the interbank market or directly from the central bank (Fullwiler 2012). On the other hand, prudential regulations became much more rigid after recent financial crises. Unlike the reserve requirement which focuses only on the reserve holdings, prudential regulations limit bank lending and the money supply based on the sufficiency of banks' liquidity and capital positions against maturity mismatch and default loss (Li et al. 2017). Despite the extensiveness of the literature on the macroeconomic impacts of prudential regulations, there are few studies on their roles in the money creation process.

To fill in this knowledge gap, we take the Basel III accord as the representative framework for prudential regulations and examine its impact on commercial banks' ability to create money.

2. The balance sheet approach

A bank's balance sheet reflects its current financial condition. Banking regulations are usually based on the minimum ratios between the components of bank balance sheet. To elaborate the roles of commercial banks in the money creation process and their behaviors under different regulations, we propose here a simple balance sheet approach.

We consider a representative commercial bank with a simplified balance sheet as shown in Table 1. There are two types of assets: reserves (R) with high liquidity and

Table 1. Balance sheet for a representative commercial bank

Asset	**Liability**
Reserves (R)	Deposits (D)
Loans (L)	Equity (E)

zero risk, and loans (L) with low liquidity and a risk weight of γ. On the liability side, there are deposits (D) and equity (E). To make the balance sheet even,

$$R + L = D + E. \tag{1}$$

Assuming no cash is held by the public, we have the monetary base $MB = R$ and the broad money supply $M = D$. The corresponding money multiplier is

$$m = \frac{D}{R}. \tag{2}$$

When a loan is made (repaid), there is an identical and simultaneous increase (decrease) in the stocks of loans and deposits. Driven by profits, the banking system is inclined to increase lending regardless of the underlying risks. Unlike the fast and easy expansion of loans and deposits, increases in reserves and equities are much slower

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and more dependent on external forces[1]. For simplicity, we assume R and E are exogenously given and

$$E = e * R, \tag{3}$$

where e is the equity-to-reserve ratio.

As an example for the balance sheet approach, we demonstrate here how the reserve requirement limits money creation. Denoting the real reserve ratio as r and the required reserve ratio as $r_{\min}$, we have

$$r = \frac{R}{D} \geq r_{\min}. \tag{4}$$

We force (4) to take equality and combine it with (2) to derive at the maximum money multiplier under reserve requirement,

$$m_{RR} = \frac{1}{r_{\min}}. \tag{5}$$

Note that m_{RR} is obtained when the banking system reaches its maximum capacity of credit creation given the required reserve ratio $r_{\min}$. The maximum money multiplier is a regulation specific concept which is equal to the real money multiplier only when the concerned regulation is the most rigid constraint. We next use this approach to derive the corresponding formulas of maximum money multiplier for the following three Basel III regulations.

3. Money multiplier under Basel III regulations

The purpose of the Basel III accord is to reduce banks' risk exposure and improve financial stability (Committee et al. 2010). It introduces a minimum liquidity coverage ratio to promote the short-term resilience of banks' liquidity risk profile, requires an increase in the risk-based capital adequacy ratio to ensure adequate holdings of bank equities against solvency risk, and imposes a leverage ratio to restrict the build-up of excessive leverage.

3.1. *Liquidity coverage ratio (LCR)*

The liquidity coverage ratio (LCR) regulation requires banks to hold sufficient unencumbered high liquid assets ($HQLA$) that can cover the expected net cash outflows ($NCOF$) during a 30-calendar-day liquidity stress scenario (Basel III 2013). We compute the real LCR from the bank's balance sheet and denote the minimum policy requirement as $LCR_{\min}$.

Because the only qualified high quality liquid asset in our model is reserves, we have

$$HQLA = R. \tag{6}$$

[1]Total reserves are ultimately determined by the central bank while the increase of bank equities requires issuing more shares or keeping more retained earning.

On the other hand, Basel III defines

$$NCOF = OF - min\{IF, 0.75OF\}, \tag{7}$$

where OF is the total expected cash outflows and IF is the total expected cash inflow. In our case, OF is equal to the deposit loss with an expected run-off ratio of μ during a 30-day horizon, i.e.

$$OF = \mu D. \tag{8}$$

On the other hand, IF is computed as the total amount of repayments (RP) that are performing and contractually maturing for the given time period with a discount of 50% due to the stressed scenario hypothesis, as given by

$$IF = 0.5RP. \tag{9}$$

Suppose RP is proportional to the outstanding loans with a ratio of λ, we can rewrite (9) as

$$IF = 0.5\lambda L. \tag{10}$$

To comply with LCR regulation, the real LCR should be no less than the minimum requirement, i.e.

$$LCR = \frac{HQLA}{NCOF} = \frac{R}{\mu D - min\{0.5\lambda L, 0.75\mu D\}} \geq LCR_{\min}. \tag{11}$$

Forcing (11) to take equality and combing it with (1) and (3), we can obtain the maximum money multiplier under the LCR regulation,

$$m_{LCR} = \begin{cases} \frac{4}{\mu * LCR_{\min}}, \lambda \geq \frac{1.5\mu}{1+0.25\mu(e-1)*LCR_{\min}}; \\ \frac{1+0.5\lambda(e-1)*LCR_{min}}{(\mu-0.5\lambda)*LCR_{min}}, \lambda < \frac{1.5\mu}{1+0.25\mu(e-1)*LCR_{\min}}. \end{cases} \tag{12}$$

From (12), we see that m_{LCR} is negatively dependent on $LCR_{\min}$ and μ. When $\lambda < \frac{1.5\mu}{1+0.25\mu(e-1)*LCR_{\min}}$, m_{LCR} is a increasing function of e and λ.

3.2. *Risk-based capital adequacy ratio (CAR)*

The risk-based capital adequacy ratio (CAR) is defined as the ratio of the bank's equity holdings to the total risk-weighted assets (RWA). Because the risk weight of reserves is zero and that of loans is γ,

$$RWA = \gamma * L + 0 * R = \gamma L. \tag{13}$$

Thus banks in conformity with the CAR regulation must satisfy

$$CAR = \frac{E}{RWA} = \frac{E}{\gamma L} \geq CAR_{\min}, \tag{14}$$

where CAR and $CAR_{\min}$ respectively denote the real CAR and the minimum policy requirement.

When (14) takes identity and is combined with (1) and (2), the maximum money multiplier under CAR requirement can be derived,

$$m_{CAR} = 1 + e(\frac{1}{\gamma * CAR_{\min}} - 1). \tag{15}$$

From (15), we can infer that m_{CAR} is an increasing function of e and a decreasing function of $CAR_{\min}$ and γ.

3.3. *Leverage ratio (LR)*

The leverage ratio (LR) is the ratio between bank equity and total assets (TA). The real leverage ratio LR should be no less than the required ratio $LR_{\min}$, i.e.,

$$LR = \frac{E}{TA} \geq LR_{min}, \tag{16}$$

where $TA = L + R$.

Similarly, the corresponding maximum money multiplier under the LR regulation is

$$m_{LR} = e(\frac{1}{LR_{\min}} - 1). \tag{17}$$

From (17), we conclude that m_{LR} decreases as $LR_{\min}$ increases, and increases as e increases.

4. Conclusion

We have shown that both the reserve requirement and prudential regulations affect money creation. By expressing the maximum money multiplier as a function of the minimum required ratio of each regulation and the parameters related to banks' liquidity and equity positions, we find that commercial banks can create more money when the binding regulation is loose, when it faces low deposit run-off ratio and loan default risk, and when it has a high loan repayment ratio and sufficient equity holdings relative to the total reserves. The versatility of the maximum money multipliers under different regulations provides an explanation alternative to the FRT for the unexpected empirical facts that increases in total reserves do not "multiple up" to bigger changes in the broad money supply but may result in the decrease of the real money multiplier, as exemplified by what happened in the U.S. and Europe after the implementation of the quantitative easing policy during recent crises (Carpenter and Demiralp 2012).

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