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THE BASEL CAPITAL REQUIREMENT, LENDING INTEREST RATE, AND AGGREGATE ECONOMIC GROWTH: AN EMPIRICAL STUDY OF VIET NAM

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Abstract

In recent years, the Vietnamese economy has shown signs of financial distress, and especially small banks have experienced serious liquidity and solvency problems. Based on the new policy of the State Bank of Vietnam, in order to ensure safe and effective banking operations, the Basel II accord will be widely applied to the whole banking system by 2018. This paper investigates the effects of the Basel II capital requirement implementation in Viet Nam on the bank lending rate and national output. The paper provides a theoretical framework as well as empirical model by developing a Vector Error Correction Model (VECM) over the period 2018 to 2016 by employing three groups of indicators (macroeconomics, banking, and monetary). The main finding of the paper is that at the bank level, a tightening of regulatory capital requirements does not induce a higher lending rate in the long run. Also, changes in micro-prudential capital requirements on banks have statistically significant spillovers on the GDP growth rate in the short term; yet, their effects significantly lessen over a longer period.

Keywords: Basel II, regulatory capital requirements, bank capital, lending rate, aggregate growth

JEL Classification: G21, G28

Contents

1. INTRODUCTION

Acting as by far the most important financial intermediaries, banks have a principal say over a country's economic development as a whole. With a bank lending boom in times of economic thriving, there have also been surges in consumption and asset prices within private and corporate sectors. In comparison, under an economic downturn, banks reduce their lending volume, which may put production and other sectors in jeopardy. Therefore, the vulnerability of the banking system is regarded as a main cause of financial instability, affecting the entire economy. For those reasons, guaranteeing the financial soundness of banks is one of the major targets of supervisors and regulators all over the world. The Basel frameworks on capital requirements were introduced to achieve this goal (BCBS, 2001).

Finalized in 1988, Basel I was the first accord on capital requirement and standards issued by the Basel Committee on Banking Supervision (BCBS). Accordingly, all international banks are required to reserve at least 8% of capital based on their risk-weighted asset volume (BCBS, 1988). However, Basel I is criticized for only focusing on credit risks and ignoring other types of risk that could also threaten banks' safety.

In order to complement loopholes in Basel I, the second version was introduced in 2006 by BCBS (2006). Besides tightening regulations on supervisory review and market discipline, the new accord also requires banks to take credit risks, market risks, and operational risks into account, solidifying banks' activities at the time. While maintaining the minimum capital adequacy level at 8%, the risk-weighted assets (RWA) for credit assessment are more risk-sensitive due to the significant changes to the approaches used to measure credit risk. Specifically, credit risk can be assessed by a standardized approach that allows banks to use an external credit-rating system or an internal ratings-based approach (IRB).

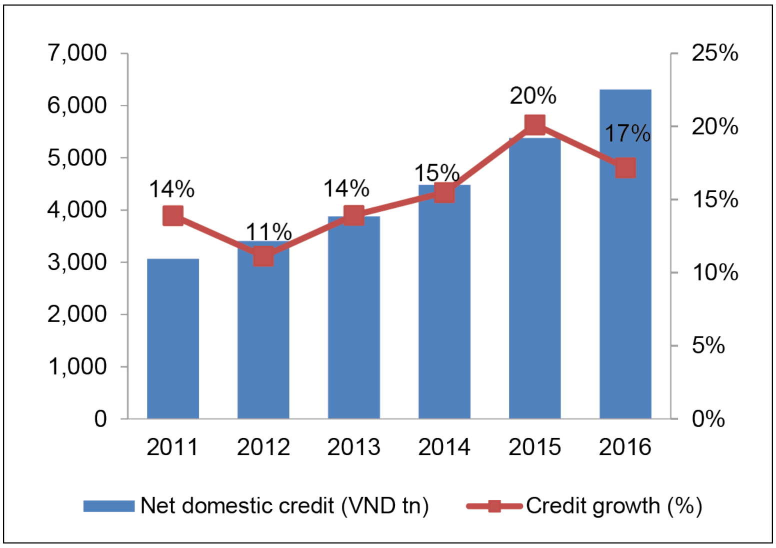
The 2008 great financial crisis has revealed many deficiencies of the existing regulations, including the Basel II framework, leading to the emergence of the Basel III accord in 2011. Basel III strengthens the regulatory capital in terms of both level and quality of capital compared to Basel II. In addition to the minimum overall regulatory capital ratio of 8% being left unchanged, Basel III introduces leverage and liquidity requirements of an additional 3% on tier 1 capital to safeguard against excessive borrowing and ensure that banks have sufficient liquidity during financial stress. Furthermore, the minimum tier 1 capital rises from 4% to 6% over risk-weighted-assets, of which the majority must be of the highest quality (common shares and retain earnings).

In recent years, the Vietnamese economy has shown signs of corporate and financial distress and weaker growth. Several segments of the corporate sector exhibit poor performance and financial distress,[1] and have affected the health of the banking system. Therefore, the Vietnamese banking system has experienced a relatively long period of poor performance and vulnerable development.

Viet Nam has experienced rapid credit growth, surpassing those of the countries with similar development level (IMF, 2017). As can be seen in Figure 1 and 2, credit growth reached a peak at 20% in 2015 and its credit-to-GDP ratio continuously grew from 105% in 2012 to a high level of 140% in 2016.

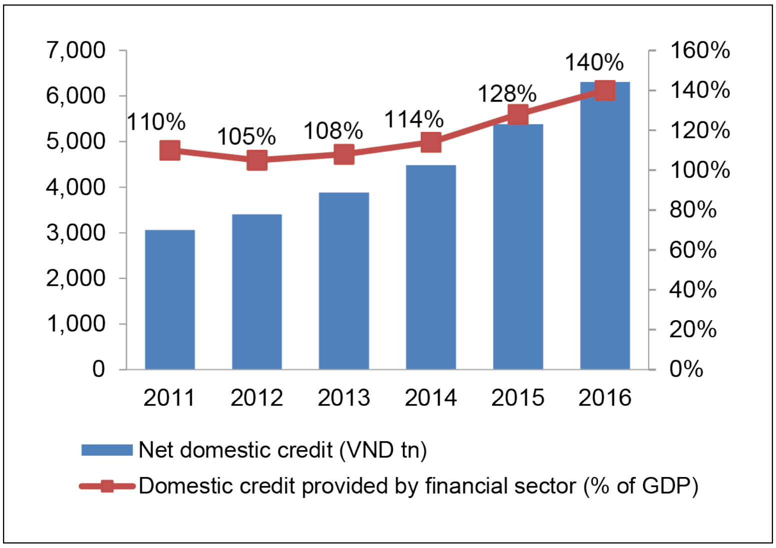
[1] Many large state-owned enterprises have defaulted on their liabilities, while some are over-leveraged.

Figure 1: Credit Growth in Viet Nam



Source: Authors' compilation from World Bank data, 2017.

Figure 2: Credit to GDP in Viet Nam

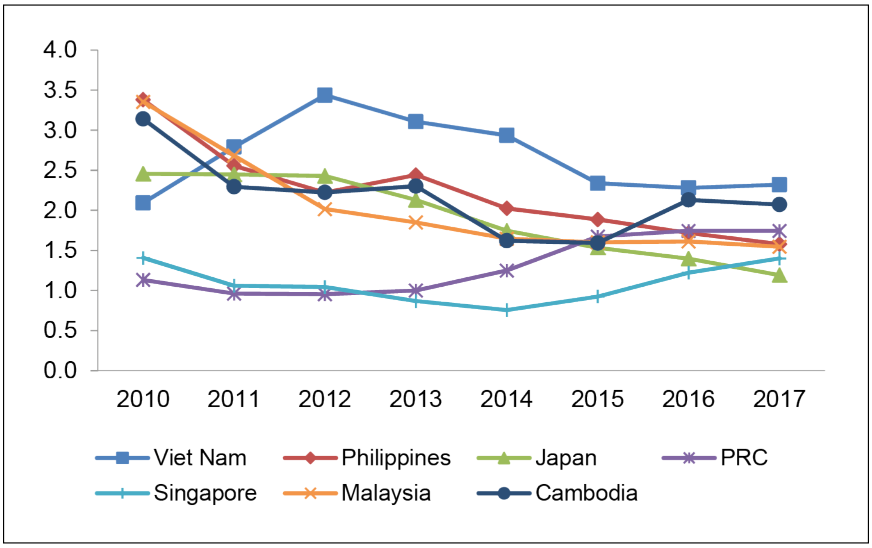


Source: Authors' compilation from World Bank data, 2017.

However, *bad debts and non-performing loans* have been a big problem facing the Vietnamese banking industry.[2] In fact, many small banks have experienced serious liquidity and solvency problems in recent years, leading to interventions by the State Bank of Vietnam (SBV). The reduced lending capacity of the banking system is one of the factors that have contributed to a sharp slowdown of credit growth (World Bank, 2014). Figure 3 compares the bank's non-performing loans to total gross loans (%) in Viet Nam with selected Asian economies.

2 In an attempt to strengthen commercial banks' balance sheet, Vietnam Asset Management Company (VAMC) was created. However, the operation of VAMC failed to solve the problem from its roots.

Figure 3: Bank Non-performing Loans to Total Gross Loans (%) **in Selected Asian Economies (2010–2017)**



Source: Authors' compilation from Financial Soundness Indicators by IMF.

As a result, the State Bank of Vietnam (SBV) issued Directive No.01/CT-NHNN in January 2017 on implementing monetary policies in order to ensure safe and effective banking operations. Accordingly, the Basel II accord will be widely applied to the whole banking system by 2018. This is expected to help the Vietnamese banking system improve its competitiveness, governance, and risk management in the context that the Viet Nam economy has become increasingly integrated into the global economy.

Nevertheless, the application of Basel II in the Viet Nam banking system has also raised a concern that stricter capital requirements that banks need to reserve might give rise to banks' lending rates, due to the higher cost of lending out. This may further lead to a credit crunch, hence imposing a negative impact on the economy as a whole. Especially, in the context of Viet Nam, whose financial system is bank-based, meaning that businesses depend on banks as the main source of financing, the impact of increased lending rates due to higher capital reservation, thus smaller lending volume, could become more serious.

This paper examines the possible impact of capital requirement, controlling for other explanatory variables, on banks' lending activities, thus aggregate growth. To do that, we simulate an empirical model to testify our hypotheses. After an extensive literature review, a semi-structural Vector Autoregressive (VAR) model is developed by employing various explanatory variables. Prior studies have revealed that there are different proposals for applying an adjustment factor to the Basel capital requirement ratio, thereby eliminating discretion by regulators. Himino (2009), for example, proposes a stock price index as an adjustment factor, Yoshino and Hirano (2011) proposed GDP growth, credit growth, stock price, and real estate price index as adjustment factors. This paper is providing a more comprehensive analysis compared to earlier papers and exploring test results of the hypothesis based on various macroeconomic indicators (GDP, CPI), bank indicators (loan, deposit, capital adequacy ratio), monetary variables (interest rate and exchange rate) using quarterly data 2008Q1 – 2016Q4 of Viet Nam. The empirical analysis provides insightful conclusion and policy implications for the Vietnamese government and other developing countries that planned for implementation of the Basel capital requirement in their banking system.

2. THE APPLICATION OF THE BASEL CAPITAL REQUIREMENTS WITHIN THE VIETNAMESE BANKING SYSTEM

In Viet Nam, according to the SBV, the adoption of Basel II widely within the banking industry is a must to guarantee a sound and solvent system. In an attempt to materialize the Basel II framework in Viet Nam, SBV have incorporated several regulations concerning the accord into its documents.

In 2005, SBV announced safety ratios in lending activities of credit institutions whose computing approaches converged with the Basel I accord. Among those ratios, capital adequacy ratio (CAR) was stated to be at least 8% (SBV, 2005b). Nonetheless, the discrepancies between Vietnamese accounting standards and international ones deterred CAR calculations from fully satisfying Basel requirements. In addition, a CAR of 8% was required to be maintained by banks of all scopes, sizes, and risk pools.

Upon the outbreak of the financial crisis in 2008, Viet Nam has been seriously impacted (World Bank, 2010). Within the country, a large quantity of capital and credit ran into real estate and stock markets, leading to a serious credit risk problem. The previous regulations became inadequate. Consequently, the SBV raised the minimum required CAR from 8% to 9% via a new *Circular 13* in 2010 (SBV, 2010). The calculation of CAR was again developed based on the Basel I accord. However, the denominator took into account credit risks only, overlooking market risks and operational risks.

Moreover, in 2014, *Circular 36* was issued, setting up new banking regulation standards. Under the circular, CAR continued to be maintained at 9% at minimum. Nevertheless, compared with Circular 13, it was better developed, with the CAR formula being adjusted to be more detailed and transparent (Hoang Thi Thu Huong, 2017).

Afterwards, in December 2016, the SBV announced the issuance of *Circular 41* stipulating minimum capital adequacy ratio among commercial banks in Viet Nam. Compared with previous regulatory documents relating to banks' capital, this Circular is considered to be closer to the Basel II accord. In addition to adjusting the CAR from 9% to 8%, Circular 41 also complements capital buffers for market and operational risks apart from credit risks. The Circular is to be fully implemented starting on the first day of 2020 (SBV, 2016).

In fact, Vietnamese banks have managed to sustain a relatively high level of CAR compared with the requirement under Circular 13, with the mean value of the whole industry exceeding 9%. Table 1 provides information on the CAR ratio of Vietnamese banks. As can be seen, the level of CAR in state-owned commercial banks, although satisfying regulatory requirements, is at risk of falling down in the case of a full implementation of Basel II. Meanwhile, joint-stock commercial banks are better capitalized thanks to higher CAR rates.

Table 1: CAR Ratios of Vietnamese Banks (%)

	2012	2013	2014	2015
State-owned commercial banks (SOCBs)	10.28	9.40	9.40	9.42
Joint-stock commercial banks (JCBs)	14.01	12.07	12.07	12.74
The whole industry	13.75	13.25	12.75	13.14

Note: CAR: capital adequacy ratio.

Source: SBV annual report 2012-2015 and authors' compilation.

However, it is worth noting that those ratios were computed based on Basel I standards. According to the National Financial Supervisory Commission (NFSC) (2017), when Basel II is fully applied, those banks have difficulties maintaining their current CAR level owing to the rise in risky assets they have taken in.

3. LITERATURE REVIEW AND THEORETICAL MODEL

3.1 Literature Review

Conventionally, lending is an inherent function of banks. Factors affecting lending growth consist of bank capital (Naceur et al., 2018; Kosak et al., 2015), bank liquidity (Kim and Sohn, 2017) and bank supervision (Kupiec, Lee and Rosenfeld, 2017). The Basel capital requirements were introduced as a way to monitor and supervise bank activities. Indeed, a number of empirical studies have been devoted to investigating the impact of capital requirements on lending activities of banks and produced rather mixed outcomes.

On one hand, several research studies support the significant short-run negative impact of capital requirements on bank lending and growth (i.e. Aiyar et al., 2014a, 2014b; Meeks, 2017; Noss and Toffano, 2016). Employing UK bank data, Aiyar et al. (2014a, 2014b) found that an increase in capital requirements of one percentage point reduces the growth rate in real lending by 4.6% and credit growth by 6.5–7.2%. Meeks (2017) presents new evidence on the macroeconomic effects of changes in regulatory bank capital charges, using confidential data from the Basel I and II implementation in the United Kingdom. The results show that an increase in capital requirements reduces lending to firms and households, causes a decline in total expenditure, and widens credit spreads. Specifically, secured household lending reduces by 0.5% after 18 months, and non-financial corporate lending is around 1.5% lower. These findings are also in line with the study by Noss and Toffano (2016); however, the impact on GDP growth is found statistically insignificant.

On the other hand, when assessing the impact of capital requirements on lending activity over a longer timeframe, the results are less significant. For instance, Kashyap et al., (2010) propose that in the long-run, the effects of tightened capital regulation are hard to assess, and the impact on lending and real activity is likely to be modest. In addition, the MAG (2010) points out that a one percentage point increase in the target ratio of capital would lead to a decrease in the level of GDP of about 0.15 percent. But such a decline would likely occur about eight years after the start of implementation. These estimates imply that the long-run effects of an increase in capital requirement may be very small.

Interestingly, De Nicolo et al. (2012, 2014), calibrating the model using US banking data, find an inverted U-shaped relationship between bank lending and capital requirements. Accordingly, when capital requirements of Basel II type are between 1–2%, banks will lend more, which allows them to accumulate retained earnings through increased revenues. The quantitative impact of an increase in required capital from 0 to 2–3% is a sizable 15% increase in lending. However, once the capital requirement crosses the 3% threshold, the optimal strategy for banks is to cut back on lending because of diminishing returns to investment relative to the cost of capital. More specifically, an increase in the capital ratio from 4 to 12% leads to a decline in lending by about 2.4%. This finding is consistent with Begenau (2015); however, the optimal regulatory capital ratio under the latter study is much higher, at 14%.

Contradicting previous findings, Francis and Osborne (2012) propose that by following a change in capital requirements, banks are inclined to adjust their asset portfolios by altering the composition rather than the volume of loans and other assets, for instance by shifting toward lower risk-weighted assets. In terms of capital, banks tend to focus on relatively inexpensive, lower quality, tier 2 capital, rather than higher quality, tier 1 capital.

When looking closer at the impact of changes in capital requirements on lending interest rates, two possible scenarios might emerge. On the one hand, an increase in regulatory capital standards is associated with an increase in the funding costs of banks as equity capital becomes more expensive. Thus, banks are likely to pass this on to borrowers by raising interest rates on loans. On the other hand, a better-capitalized bank is less risky, which is likely to lead to reduced required rates of return on both debt and equity. The overall impact would leave the lending rate unchanged as a result.

Nonetheless, empirical evidence shows slightly different outcomes on lending rates. BCBS (2010), when examining 6,600 banks on 13 OECD countries from 1993 to 2007, highlights that one percentage point increase in the capital ratio results in a median increase in lending spreads of 13 basis points. Kashyap et al. (2010) find that a 10% increase in capital requirement results in an increase of 2.5 to 4.5 basis points on loan rates. Similar results are obtained through studies by Elliott (2009) and Slovik and Cournede (2011). However, these findings suggest one common feature that the long-run effects of higher capital requirements on lending rates are relatively small (Rochet, 2014). Osborne (2016) provides different evidence that there is a pronounced cyclical instability in the relationship between bank capital and lending rates. However, his literature review also identifies that this relationship should be stable over time once fully controlling for aggregate macroeconomic and bank-specific variables.

Other studies regarding this topic focus on the contributing factors. The analysis by Drumond and Jorge (2013) suggests that the overall impact of risk-based capital requirements on loan interest rates depends on the distribution of risk and leverage across firms and on the market structure of the banking sector. The empirical results by Said (2013) show that average rates of banks' loans are mainly influenced by market rates on loans and policy rates. Also, risk-weighted assets under Basel I play an important role in influencing the optimal rates on loans and time deposits.

3.2 Theoretical Model

This section provides the theoretical background of the paper for showing the relationship between banks' lending interest rate and capital adequacy ratio, price level, deposit, loan, exchange rate, and GDP.

Eq. 1 shows the bank's profit equation, where π denotes bank's profit, $\mathrm{r_L}$ denotes bank's lending interest rate, L is the amount of bank loan, ρ is probability of default of bank loans, which is a function of amount of bank loan and capital adequacy ratio (CAR). If the amount of loan increases and there is no sufficient monitoring scheme, a portion of lending will be allocated to riskier sectors that will increase the non-performing loan ratio of banks, which will then increase the probability of loan default. In addition, if the capital adequacy ratio (CAR) increases, ρ will reduce, r_D denotes the deposit interest rate, D is the amount of deposits that banks receive, and C_b denotes the total operational costs of bank, which is a function of loan supply and the amount of deposits. For simplicity we are assuming that banks keep all of their assets in the forms of loan and reserve requirements at the central bank. Based on the bank balance sheet, loan and reserve requirements are equal to deposit and capital of bank.

Bank's Profit equation: $\pi = r_L L - \rho(L, CAR)L - r_D D - C_b(L)$ (1)

Subject to: Balance Sheet of Bank $kD + L = D + A \rightarrow D = \frac{L-A}{1-k}$

Where k is the reserve requirement ratio. Then the equation (1) could be rewritten as:

$$\pi = r_L L - \rho(L, CAR)L - r_D \frac{L-A}{1-k} - C_b(L) \quad (2)$$

Bank's cost function: $C_b = c_1 L + cL^2 + d_1 D + d_2 D^2$ (3)

The ultimate goal of banks is to maximize their profit. For simplicity, we assume that lending activities are the major source of banks' profitability and banks are considered to lend out up to an optimal level to make the most profit. In order to find the optimal point of banks' profit, we initially differentiate the equation (2) with respect to loan (L) to get:

$$\frac{\partial \pi}{\partial L} = [r_L L - \rho(L, CAR)] - \frac{r_D}{1-k} - \frac{\partial C_b}{\partial L} \quad (4)$$

Where $\frac{\partial C_b}{\partial L} = \gamma_0 + \gamma_1 L$ (by differentiating eq. (3)). Next, we set eq. (4) equal to 0 and get the equation of optimal supply of loan banks provide:

$$L^s = s_0 + s_1[r_L L - \rho(L, CAR)] - s_2 \frac{r_D}{1-k} \quad (5)$$

Meanwhile, from a loan demand perspective, we assume that the majority of demand for loans comes from production firms whose production function counted on yearly basis is:

$$Y = AF(K, N) = bK^{\alpha} N^{\beta} \quad (6)$$

Equation 6 shows the production function of a specific firm. We are assuming that the capital of this firm is borrowing in the form of a loan from bank. Production function in eq. 6 is in Cobb-Douglas form, where Y is total production value of firms; K and N are capital and labor inputs respectively; α, β are output elasticities of labor and capital and b is the total factor productivity.

Firm's cost function: $C_f = r_L K + \omega N$ with $\mathrm{r_L}$ and ω being lending rate and labor wage.

Therefore, the profit function of a firm (π_f) takes the form of equation 7:

$$\pi_f = bK^{\alpha}N^{\beta} - \mathrm{r_L}K - \omega N \quad (7)$$

Similar to banks, firms aim to maximize their profit. To find this possible maximum level of profit earned by firms, we also differentiate eq. (7) with respect to the amount of capital input and get:

$$\frac{\partial \pi_f}{\partial K} = \alpha \frac{Y}{K} - r_L \quad (8)$$

Setting eq. (8) equal to 0, we have: $= \alpha \frac{Y}{r_L}$. As mentioned earlier we assumed capital of firm is financed completely by bank loan. Therefore, the loan demand (L^d) equation can take the form of equation 9:

$$L^d = \alpha_0 - \alpha_1 r_L - \alpha_2 Y \quad (9)$$

The equilibrium point is where the loan demand is equal to loan supply, therefore the equilibrium point between loan demand and supply is the solution of the following eq. 10:

$$s_0 + s_1[\mathrm{r_L L} - \rho(\mathrm{L, CAR})] - s_2 \frac{\mathrm{r_D}}{1-k} = \alpha_0 - \alpha_1 \mathrm{r_L} - \alpha_2 Y \quad (10)$$

By writing eq. 10 for the lending interest rate, we obtain the lending interest rate equation (eq. 11):

$$r_L = \frac{1}{(s_1 + \alpha_1)} \{\alpha_0 - s_0 + s_1\, \rho(L, CAR) + s_2 \frac{r_D}{1-k} - \alpha_2 Y \quad (11)$$

As is clear from eq. 11, the lending interest rate is a function of various factors, including the default risk ratio of banks, which is a function of amount of loan and CAR, the deposit interest rate, reserve requirement ratio, and the GDP. This equation provides the theoretical background for the explanatory variables that we use in the empirical part in Section 4.

4. EMPIRICAL ANALYSES

4.1 Data Specification

In addition to the determinates of the lending interest rate that were obtained from eq. 11, we added two more control variables to the empirical model, which are consumer price index (CPI) and exchange rate. Table 2 shows the definition of the variables used in this research, along with their data sources. In this research, we use a set of quarterly data from 2008: Q1 to 2016: Q4.

Table 2: Data Specification

No	Notation	Variable Specification	Unit	Source
1	CAR	Capital adequacy ratio	Percentage	State Bank of Vietnam
2	CPI	Consumer Price Index	Percentage	State Bank of Vietnam
3	DEPOSIT	Total third-party fund in banking industry	D billion	State Bank of Vietnam
4	EXCHANGE RATE	Domestic currency to US dollar rate	Unit	State Bank of Vietnam
5	GDP	Gross Domestic Product	D billion	State Bank of Vietnam
6	LOAN	Total loans	D billion	State Bank of Vietnam
7	INTEREST RATE	Official 3 week – Inter-bank Interest Rate issued by the State Bank of Vietnam	Percentage	State Bank of Vietnam

Source: Authors' compilation.

4.2 Data Analysis

4.2.1 Unit Root Test

According to Johansen (1991), with time series data, the stationarity of each variable needs to be achieved. Only when all the measured variables are stationary is VAR stationarity achieved. For that purpose, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are employed, using the confidential level of 5% and automated lag length of 9 (according to Akaike information criterion). Accordingly, if the tests' statistic values (p-value) are smaller than the critical value of 0.05, the analyzed series is considered stationary. Table 3 below indicates the results of the test:

Table 3: Summary of Unit Root Tests

	Augmented Dickey-Fuller		Phillips-Perron	
Variable	***At Level***	***1st Difference***	***At Level***	***1st Difference***
CAR	–1.88 (0.34)	–5.78** (0.00)	–1.88 (0.34)	–5.78** (0.00)
CPI	–4.63** (0.00)	–3.43* (0.02)	–1.82 (0.36)	–3.63** (0.01)
DEPOSIT	4.51 (1.00)	–2.26 (0.19)	7.86 (1.00)	–4.65** (0.00)
EXCHANGE RATE	–2.24 (0.20)	–4.09** (0.00)	–2.09 (0.25)	–4.03** (0.00)
GDP	–0.39 (0.90)	–28.59** (0.00)	–3.18* (0.03)	–22.47** (0.00)
LOAN	2.37 (1.00)	–2.75 (0.08)	2.01 (1.00)	–6.48** (0.00)
INTEREST RATE	–2.35 (0.16)	–4.65** (0.00)	–1.18 (0.67)	–4.74** (0.00)

Note: *,** denotes significant level of 0.05 and 0.01 respectively; values out of parentheses are t-value.

Source: Authors' compilation.

Based on the results from Table 3, it is evident that with the Augmented Dickey-Fuller test, all variables except CPI are not stationary at their level. Therefore, transformations are required. Using their first difference, almost all variables achieved stationarity, except for DEPOSIT and LOAN. However, the results of Phillips-Perron (PP) tests indicate that all series are stationary at the first difference with all p-values are smaller than 0.05. When series are non-stationary at level and stationary at the first differences, series are integrated of order 1 or I(1), next step of data analysis is to check for the present of cointegration.

4.2.2 Cointegration Analysis

As documented above, model variables are non-stationary at levels. Thus, one may concern of the presence of long-run correlation among them (Hall and Henry, 1989). In case of non-cointegration among levels, meaning variables could not have any long-term association, VAR model is employed (Dickey et al., 1991). Otherwise, VECM, which allows the combination of both short-term and long-term relationships among model variables, is adopted.

Thus, in this step, in order to test for the existence of long-run relationships among variables, Johansen's integration test, which was developed and proposed by Johansen and Juselius (1990) and Johansen (1991), is employed. Both trace test and maximum eigenvalue tests are performed using lag length of 2 which is generated from AIC and HG lag selection tests[3]. The results of both tests are presented in Table 4.

Table 4: Johansen Cointegration Test Summary

Unrestricted Cointegration Rank Test (Trace)			
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**Prob.**
*None**	0.995	416.090	0.000
*At most 1**	0.973	240.422	0.000
*At most 2**	0.764	120.823	0.000
*At most 3**	0.695	73.193	0.000
*At most 4**	0.457	33.968	0.016
At most 5	0.231	13.810	0.088
*At most 6**	0.144	5.138	0.023
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)			
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**Prob.**
*None**	0.995	0.995	0.000
*At most 1**	0.973	0.973	0.000
*At most 2**	0.764	0.764	0.001
*At most 3**	0.695	0.695	0.001
At most 4	0.457	0.457	0.068
At most 5	0.231	0.231	0.315
*At most 6**	0.144	0.144	0.023

Note: * denotes rejection of the hypothesis at the 0.05 level, order of variables: INTEREST RATE, EXCHANGE RATE, CAR, DEPOSIT, LOAN, CPI, GDP.

Source: Author's compilation.

[3] See Appendix I.

As can be seen from Table 4, estimation results indicate that the number of cointegrating equations for the trace and maximum eigenvalue is 5 and 4 respectively. This implies that variables are cointegrated. In other words, there exist long-run relationships among tested variables including CAR, CPI, DEPOSIT, EXCHANGE RATE, LOAN, GDP, and INTEREST RATE. Thus, we will rely on vector error correction model (VECM) rather than conventional VAR.

4.3 Empirical Results

4.3.1 Vector Error Correction Model (VECM)

As mentioned before, in this study, we estimate our empirical model using VECM setting. The variables used in the model are INTEREST RATE (interest rate), CAR (capital adequacy ratio), CPI (inflation), DEPOSIT (deposits), EXCHANGE RATE (exchange rate), LOAN (loan size). Among them, we define DEPOSIT, LOAN, EXCHANGE RATE, and GDP in logarithmic forms.

Furthermore, the ordering of variables determines the way in which they affect each other. According to Sims (1992), the policy variable, such as leading indicator of monetary policy, is ordered first. Gertler and Gilchrist (1993), in their research, also propose the positions of tested variables as following: interest rate (INTEREST RATE), bank deposits (DEPOSIT), bank loans (LOAN), capital adequacy ratio (CAR), exchange rate (EXCHANGE RATE), output (GDP) and prices (CPI). While referring to prior studies, we make necessary modifications to our ordering. Since Viet Nam is an export-oriented country, the influential magnitude of any fluctuation in exchange rate on interest rate is expected to be high and should be ordered right after interest rate. Besides, once Basel II is implemented, CAR is also a policy variable and is more exogenous than LOAN or DEPOSIT, and thus, should be placed third in the ordering chain. Thus, our ordering is: INTEREST RATE, EXCHANGE RATE, CAR, DEPOSIT, LOAN, CPI, GDP. To the end, our VECM is specified as eq.:

$$dV_t = M(O)V_r + \Pi V_{t-1} + \varepsilon \quad (12)$$

Where: *V* = *(INTEREST RATE, EXCHANGE RATE, CAR, DEPOSIT, LOAN, CPI, GDP)*

Π is the number of variables in V and can be written as Π= ab' with a and b being $\Pi \times r$ matrices; and r being the rank of Π.

d is the first differences of variables

O is the lag operator

ε is an error term

M is a loading matrix

Also, our results from AIC standard for optimal lag suggest using lag length of 2 for these series. VECM model is employed with the aforementioned variables and ordering to investigate any significant association among tested variables and thus, answering research questions. Section 4.3.2 and 4.3.3 will provide information on the possible long-run and short-run relationships separately.

4.3.2 Long-run Relationship

As documented above, Johansen's cointegration tests confirm the presence of a long-term association among investigated variables. The long-run cointegrating relationships are given below with the values in parentheses being the standard errors:

INTEREST RATE =	1281.07Z1 -	23.14Z2 +	57.59Z3 -	134.36Z4 -	1.12Z5 -	211.07Z6
	(61.612)	(1.303)	(23.393)	(25.295)	(0.198)	(5.144)

Where: Z1 = EXCHANGE RATE; Z2 = CAR; Z3 = DEPOSIT; Z4 = LOAN; Z5 = CPI; Z6 = GDP.

Estimation results provide important insight into the investigated issues. The coefficient on exchange rate is positive, revealing that an increase in the exchange rate between the local currency and USD is likely to cause interest rate to rise. Similarly, deposit size also imposes a positive impact on interest rate. This means that an expansion of deposit size might give rise to interest rate. In contrast, CAR, contradicting our initial expectation that an increase in CAR may result in a higher interest rate, exerts negative effects on interest, meaning that even if banks are required to reserve an increasing amount of capital due to Basel II requirements, interest rates are unlikely to soar. Negative coefficient of loan also indicates that a larger pool of loans might lead interest rates to go down. A similar negative impact is witnessed in CPI and GDP with GDP having a more robust influence on interest rate.

4.3.3 Short-run Dynamics

Table 5 shows the VEC model estimates. Based on Johansen's cointegration results, the cointegrating equation sets at 4 with intercept without trend. The presence of cointegration requires at least one of the coefficients of the error correction terms (ECT) to be statistically significant. This condition is observed throughout the VEC model. For ECT2, the value of Interest rate is negative and statistically highly significant, as expected, signaling that the system is stable and converges to the equilibrium track after some disturbance in the system. In addition, when looking at values of the Interest rate (–2) row, the coefficient is only statistically significant for Interest rate, showing no short-run relationship between the policy rate and the other variables. The interest rate, in the short-term, is only affected by its lagged rates.

On the other hand, when looking at values of GDP (–2) row, for CAR the coefficient is -2.71 and statistically significant, showing that higher regulatory capital requirement under the Basel accord will reduce the national output in short time. The coefficient values for Deposit and Loan are both 0.06 and statistically significant. This means that both Deposit and Loan have positive impact on the aggregate output in short-run. On the other hand, as for Interest rate, the estimate results do not find any significant association with the GDP.

4.3.4 Variance Decomposition Analysis

In the VAR/VEC framework, variance decomposition is interpreted as the portion of the total variance of an observed variable that is due to the various structural shocks (Yoshino et al., 2014). Variance decomposition clarifies which one of the macroeconomic factors provides explanatory power for a variation in our inequality measure over different periods (Lutkepohl, 2005). *Monte Carlo error* (MCE) implemented using 100 repetitions. The variance decomposition makes it possible to determine the magnitude of each variable in creating fluctuations in other variables. The Cholesky order is shown as: Interest rate, Exchange rate, CAR, Deposit, Loan, CPI, and GDP.

Table 5: Vector Error Correction Estimates

Error Correction:	Interest Rate	Exchange Rate	CAR	Deposit	Loan	CPI	GDP
ECT1	0.15 [0.65]	–0.004 [–1.26]	–0.19 [–0.63]	0.006 [1.40]	0.009 [1.35]	0.94 [2.41]	–0.11 [–6.64]
ECT2	–64.89 [–3.22]	–0.34 [–1.25]	–0.55 [–0.02]	1.24 [3.20]	–0.10 [–0.17]	4.67 [0.13]	11.42 [7.97]
ECT3	2.00 [3.81]	0.006 [0.85]	–0.10 [–0.15]	–0.02 [–2.43]	0.02 [1.34]	0.15 [0.16]	–0.18 [–4.89]
ECT4	22.54 [2.50]	–0.02 [–0.16]	6.13 [0.52]	0.04 [0.24]	0.94 [3.50]	7.79 [0.50]	–1.30 [–2.02]
Interest rate(–1)	–0.15 [–1.04]	0.002 [0.83]	0.12 [0.67]	–0.006 [–2.10]	–0.005 [–1.10]	–0.31 [–1.29]	0.05 [4.42]
Interest rate (–2)	–0.45 [–2.62]	0.004 [1.92]	0.10 [0.46]	–0.004 [–1.31]	–0.003 [–0.52]	–0.53 [–1.81]	0.02 [1.42]
Loan(–1)	4.22 [0.43]	–0.09 [–0.69]	–1.14 [–0.09]	0.10 [0.55]	–0.30 [–1.03]	7.97 [0.47]	–0.52 [–0.74]
Loan(–2)	2.34 [0.26]	0.01 [0.09]	2.34 [0.20]	–0.02 [–0.10]	0.02 [0.07]	–2.34 [–0.15]	–0.37 [–0.58]
GDP(–1)	2.46 [1.69]	–0.02 [–0.80]	–2.44 [–1.29]	0.08 [2.84]	0.11 [2.54]	1.71 [0.68]	1.66 [16.00]
GDP(–2)	–0.62 [–0.62]	–0.02 [–1.66]	–2.71 [–2.09]	0.06 [3.13]	0.06 [2.13]	–1.57 [–0.92]	0.95 [13.41]

Note: t-statistics in [ ]; ECT stands for error correction term.

Source: Authors' compilation.

Table 6: Variance Decomposition of Interest Rate

Period	S.E.	Interest Rate	Exchange Rate	CAR	Deposit	Loan	CPI	GDP
1	0.77	100.00	0.00	0.00	0.00	0.00	0.00	0.00
2	1.32	84.75	9.54	1.72	2.45	1.52	0.01	0.02
3	1.62	80.88	8.40	2.31	6.17	1.60	0.358	0.29
4	2.01	74.08	6.19	3.76	12.63	2.72	0.25	0.37
5	2.52	62.25	6.22	5.74	19.80	5.48	0.28	0.24
6	2.91	53.61	4.71	9.74	24.11	7.31	0.34	0.18
7	3.23	46.18	4.08	12.05	29.36	7.50	0.63	0.20
8	3.55	40.83	3.44	12.24	34.76	7.58	0.93	0.22
9	3.81	38.46	3.01	11.89	37.53	7.88	1.03	0.20
10	**4.02**	**37.61**	**2.72**	10.94	38.98	8.51	**1.06**	**0.18**
11	4.20	38.10	2.70	10.16	39.03	8.83	0.99	0.20
12	4.40	38.95	2.84	9.60	38.33	9.13	0.91	0.24
13	4.63	39.15	3.05	9.16	37.84	9.72	0.84	0.23
14	4.87	38.59	3.56	8.91	37.55	10.36	0.81	0.21
15	5.10	37.68	4.02	8.77	37.81	10.68	0.82	0.22
16	5.34	36.59	4.18	8.79	38.51	10.84	0.86	0.23
17	5.59	35.37	4.13	8.84	39.49	11.03	0.92	0.22
18	5.81	34.30	4.01	8.65	40.51	11.34	0.99	0.21
19	6.00	33.83	3.97	8.40	41.07	11.52	1.00	0.21
20	**6.17**	**33.82**	**3.93**	8.17	41.22	11.65	**0.99**	**0.22**

Note: Cholesky ordering: Interest rate, Exchange rate, CAR, Deposit, Loan, CPI, GDP. S.E. standards for standard error.

Source: Authors' compilation.

The result of the variance decomposition for the interest rate using Cholesky is shown in Table 6. Results show that after 10 periods, firstly, 37.61% of forecast error variance of the Interest rate is accounted for by its own innovations. In other words, the lagged interest rate accounts for 37.61% of the current and the future rate. Secondly, nearly 39% of the forecast error variance can be explained by exogenous shocks to Deposit. CAR and Loan contributes to the changes in the Interest rate 10.94% and 8.51% respectively. When looking at the variance decomposition in the 20th period, the contributions change slightly. Contribution of own innovations of Interest rate reduces to 33.82%. The ratios for Deposit and Loan increase to 41.22% and 11.65% respectively, whereas the contribution of CAR drops to 8.17%.

The result of the variance decomposition for the Loan using Cholesky is shown in Table 7. During the first periods, changes in Loan are largely influenced by its own innovations and CAR, namely 60.34% and 31.51% respectively. After 10 periods, the contributions change significantly. In the 10th period, 47.78% of the forecast error variance can be explained by exogenous shocks to Deposit. Only 4.77% of forecast error variance of the Loan is accounted for by its own innovations. The CAR and exchange rate also account for the increase in Loan by 23.00% and 21.26%.

Table 7: Variance Decomposition of Loan

Period	S.E.	Interest Rate	Exchange Rate	CAR	Deposit	Loan	CPI	GDP
1	0.02	0.18	6.43	31.51	1.54	60.34	0.00	0.00
2	0.03	1.83	3.93	43.93	22.60	27.46	0.23	0.027
3	0.04	1.67	2.66	48.45	29.63	16.96	0.57	0.06
4	0.05	1.36	3.24	43.40	38.75	11.86	1.14	0.23
5	0.06	0.86	4.10	42.17	43.02	7.95	1.76	0.15
6	0.07	1.08	6.30	36.42	47.68	6.10	2.26	0.16
7	0.08	1.13	10.51	32.01	48.71	5.15	2.31	0.18
8	0.08	0.94	13.28	28.63	49.86	4.61	2.41	0.27
9	0.09	0.85	16.21	25.60	49.76	5.00	2.36	0.23
10	**0.10**	**0.72**	**21.26**	**23.00**	**47.78**	**4.77**	**2.21**	**0.26**
11	0.11	0.64	25.13	20.48	46.42	4.93	2.14	0.27
12	0.12	0.64	28.13	18.80	45.20	4.86	2.04	0.33
13	0.13	0.62	29.77	17.40	44.53	5.34	2.08	0.28
14	0.14	0.55	31.18	16.12	44.31	5.44	2.12	0.28
15	0.15	0.49	32.28	15.15	44.09	5.57	2.15	0.28
16	0.15	0.46	32.75	14.40	44.32	5.58	2.19	0.30
17	0.16	0.46	32.94	13.70	44.50	5.91	2.22	0.28
18	0.17	0.45	33.56	13.05	44.41	6.03	2.22	0.27
19	0.18	0.47	34.21	12.48	44.17	6.19	2.20	0.28
20	**0.18**	**0.52**	**34.82**	**12.07**	**43.89**	**6.23**	**2.17**	**0.30**

Note: Cholesky ordering: Interest, Exchange rate, CAR, Deposit, Loan, CPI, GDP. S.E. standards for standard error.

Source: Authors' compilation.

The result of the variance decomposition for the GDP using Cholesky is shown in Table 8. Results show that after 20 periods, firstly, almost 14.62% of forecast error variance of the GDP is accounted for by its own innovations. Secondly, 29.32% and 21.96% of the forecast error variance can be explained by exogenous shocks to monetary policy shocks— Loan and Interest rate respectively. Deposit also accounts for the increase in GDP by 19.14%. On the other hand, CAR contributed to reducing the economy output by 7.78%. In summary, among variables, Loan has the highest impact on the change of the national output.

Table 8: Variance Decomposition of GDP

Period	S.E.	Interest Rate	Exchange Rate	CAR	Deposit	Loan	CPI	GDP
1	0.06	25.05	0.12	2.20	0.27	30.45	3.86	38.06
2	0.10	14.61	0.34	13.79	19.13	28.14	2.53	21.46
3	0.10	12.97	1.57	12.85	25.22	25.25	3.11	19.04
4	0.11	11.91	6.41	12.30	23.47	25.57	2.86	17.48
5	0.12	13.80	5.55	10.07	19.20	27.18	2.65	21.55
6	0.14	15.44	3.90	9.31	21.21	29.93	2.22	17.98
7	0.15	15.11	5.08	9.05	22.00	29.12	2.26	17.38
8	0.15	14.48	6.67	9.79	20.99	29.51	2.14	16.42
9	0.16	16.66	6.24	8.78	18.85	28.92	2.26	18.29
10	**0.18**	**18.36**	**5.27**	**8.69**	**19.33**	**29.94**	**2.03**	**16.38**
11	0.18	18.19	5.34	8.46	20.47	29.53	2.08	15.94
12	0.18	17.87	6.02	8.46	20.17	29.93	2.04	15.52
13	0.19	18.97	5.69	8.01	19.08	29.53	2.02	16.69
14	0.20	19.93	5.51	8.11	19.45	29.62	1.88	15.50
15	0.20	19.92	5.42	7.98	20.12	29.39	1.91	15.25
16	0.20	19.81	5.47	8.17	19.93	29.71	1.89	15.03
17	0.21	20.73	5.27	7.82	19.11	29.37	1.95	15.75
18	0.22	21.84	5.42	7.83	18.90	29.23	1.83	14.95
19	0.22	21.98	5.35	7.74	19.26	29.08	1.83	14.76
20	**0.22**	**21.96**	**5.38**	**7.78**	**19.14**	**29.32**	**1.81**	**14.62**

Note: Cholesky ordering: Interest, Exchange rate, CAR, Deposit, Loan, CPI, GDP. S.E. standards for standard error.

Source: Authors compilation.

5. CONCLUDING REMARKS

In this paper, we provide a theoretical as well as empirical evidence on the effects of changes in regulatory capital requirements under the Basel Accords on lending rates and aggregate growth, using data from 2008 to 2016 in Viet Nam. In order to do that, we constructed a VECM model with seven variables, namely: Interest rate, Exchange rate, CAR, Deposit, Loan, CPI, and GDP. Our main finding is that CAR does not have a large impact on policy interest rate. Our estimates also show that CAR does not have a short-run relationship with the base rate. While the calculation of lending rates in Viet Nam is normally based on the policy rate, this result implies that tightened regulatory capital requirements do not induce higher lending rates. Additionally, the variance decomposition analysis shows that CAR may affect the lending capacity of banks in the short-run, but in the long-run, the effects lessen and after 20 quarters only 8% of the variance of interest rate can be explained by CAR. These findings are comparable to Noss and Toffano (2016), Kashyap et al. (2010), and Rochet (2014).

To conclude, the stricter regulatory capital requirement under the Basel Accords is a non-binding constraint on banking operations in Viet Nam. Rather, the variation of interest rate depends majorly on its own innovations; yet, this effect is inclined to weaken in the long-run. This means that stabilization of historical interest rate and accumulation of more deposits will help banks to provide a better interest rate.

With regards to GDP, our short-run dynamic analysis finds that the relationship between the aggregate output and CAR is significantly negative. However, the magnitude of CAR on the GDP lessens over longer periods. The less significant impact between capital requirements and aggregate growth over the long-term period also holds true in such a study by Kashyap et al. (2010). In sum, higher microprudential capital requirements on banks have statistically important spill-overs to the macroeconomy in short-term, yet their effects lessen over a longer period.

One possible explanation of the non-binding constraint of the Basel requirement on lending behavior comes from the CAR calculation in Viet Nam. Many banks in Viet Nam still use the standardized approach to measuring risks. Accordingly, the risk weights applied are mapped to ratings used by external rating agencies. Hence, a fixed risk weighting to assets is used to calculate the CAR, which is somewhat similar to the calculation under the Basel I framework. Catarineu-Rabell, Jackson, and Tsomocos (2003) claimed that ratings issued by external rating agencies are more stable over the business cycles, as compared to the internal rating schemes.

Nonetheless, our empirical results show a strong dependence of the aggregate output on lending and deposit. This implies that credit easing was a major driving force of high economic acceleration in Viet Nam during 2008-2016. This timeframe was also characterized by monetary easing policies by the State Bank of Viet Nam. These easing strategies, in turn, would offset the contractionary effects of the tighter macroprudential policy on national output (Meeks, 2017).

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APPENDIX I: LAG LENGTH OF VAR (P)

One pivotal issue facing the adoption of the VAR/VEC model is lag order selection to avoid an under-fitted or over-fitted VAR/VEC model. In fact, the Akaike Information Criteria (AIC), Schwarz Information Criteria (SC), and Hannan-Quinn Information Criteria (HQ) are normally used. Theoretically, lower AIC, SC and HQ values indicated a better model (Ozcicek and McMillin, 1990).

In order to determine the lag length that is optimal to the VAR/VEC model, at first, this study used the automated lag length of 2 proposed by Eview 8 software. The optimal lag, which is used for later estimations, is to be decided by AIC, SC, and HQ tests. Table 9 provides the results of the lag length test.

Table A1: Results of Lag Length Test

Lag	AIC	SC	HQ
0	143.86	144.26*	143.99
1	143.52	147.60	144.89
2	139.54*	147.30	142.15*

Note:* indicates lag order selected by the criterion at significant level of 0.05.

While the optimal lag generated from SC test is 0, both AIC and HQ selected lag 2 as the best one for the model. Therefore, in this research, the authors decided to use the lag length of 2.