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Abstract

Stylized facts in the academia have been showing that the lending behaviour of banks is procyclical, which some argue that it is an impactful factor contributing to the slow recovery of economy after the financial crisis in 2008. Due to this reason, one of the Basel III Accord's measures is an introduction of a macroprudential tool called the countercyclical capital buffer (CCyB). With reference to several empirical papers available, this paper redesigned the empirical model to test the robustness of procyclicality and reconfirmed the argument of bank procyclicality by showing a strong correlation between loan growth and business cycle (or GDP growth) Sequentially, the analysis on the effectiveness of the implementation of the countercyclical capital buffer showed that there is a strong positive correlation between the magnitude of the buffer and the credit supply growth, which hints that the countercyclical capital buffer might not be as significantly effective in dampening procyclicality as it desires. Moreover, it is also suggested that the buffer level is indeed predictable through the economic condition of the country (like GDP growth) and the buffer level of the preceding year.

Keywords: macroprudential regulations, procyclicality, countercyclical capital buffer, Basel regulations, excessive credit growth

Introduction

There are various systemic risks existing in the financial sector. Sources of systemic risks include asset price bubbles, in particular real estate bubble, liquidity provision and asset mispricing, sovereign default, contagion, currency mismatches in the banking system and multiple equilibria (Allen and Carletti, 2015). Out of these factors, the collapses in the real estate prices contributed to one of the major factors of the 2008 financial crisis. As the bubble burst in the U.S., the banks in many regions suffered from a spill-over effect that caused by the collapse in real estate price in the securitized mortgage market. Other areas of the whole economy were also hugely impacted because of the systemic risks behind. The burst of the bubble costed the financial stability of the whole sector and this unforeseeable fall has caused huge damaged to balance sheets of many financial institutions, followed by freezing of several financial markets, for example, the commonly stable interbank market (Allen and Carletti, 2015). It was argued that the loose monetary policy was the devil to blame to cause this real estate bubble, which then led to excessive credit availability (Allen and Carletti, 2015).

Subsequently, credit crunches were observed in various economic events in the history, for example in the U.S. during the 1990s, the Russian and Asian financial crises in the late 1990s (Berger and Udell, 2003). These are evidences indicating the financial system is relatively procyclical. Lending often rises drastically during economic expansions and decreases drastically when economy experiences a recession. There are a couple of key adverse consequences that may result from procyclical lending behaviour of banks. First, it aggravates business cycle and magnifies systemic risk in the financial system. Secondly, loans may not be extended to borrowers with positive NPV projects during recession as opposed to negative NPV projects will be granted for loans during expansions due to said lending behaviours of banks. This will lead to a potential inefficient misallocation of resources.

Due to this procyclicality identified and the critics received by regulators concerning the inherit procyclical tendency of the Basel II Accord, the Basel III Accord has introduced several advancements to the pre-existing foundations of Basel II regulations, as Basel II has shown clearly its incapability in dampening the systemic risks in the financial market. One of these measures is the countercyclical capital buffer, which will be discussed further later.

This paper is organized as follows. First, the paper will walk you through some literature reviews on the topic of macroprudential regulations in comparison to microprudential point of view where instead of individual bank health, the financial system as a whole is taken care of. Moreover, literature reviews on procyclicality of banks and countercyclical capital buffer will follow, where it will give a thorough explanation of the existence of procyclical lending behaviour of banks and the framework of the countercyclical capital buffer and its implementation in various countries.

The later part of the paper will give a series of empirical analyses on the evaluation of the effectiveness of the countercyclical capital buffer where the paper explored how effective the buffer is in mitigating the procyclicality of the banks. The paper will conclude with a couple of limitations addressed at the end.

Related Literatures on Macroprudential Regulations

Systemic risks are crucial to be accounted for, as these sources of risks will cause huge negative impacts to the entire economy due to the banks' negative externalities. These externalities of banks can harm the other financial institutions in the banking sector through the followings: if the financial institution is "too big to fail", "too interconnected to fail" or "too many to fail" (Schwerter, 2011).

The systemic risk could hurt the financial system in two dimensions, i.e. cross-sectional and time series dimension (Schwerter, 2011). In cross-sectional effects, the systemic risks have spillover effects that one individual firm is, for example, too massive in size that when it fails, it hurts its peers in the financial system. This procedure is known as the domino or contagion effects. On the other hand, the time dimension affects the same single bank over time elapses and gives rise to the problem of procyclicality (Schwerter, 2011).

Asset price bubbles contribute as one of the many reasons of financial crises due to the nature of systemic risks as mentioned in the introduction section. Macroprudential regulations that tackle an asset price bubble would be giving efforts to avoid such bubbles to build up over time, even though it is difficult to anticipate a bubble, it is not unachievable (Allen and Carletti, 2015). Relaxed monetary policy and excessive credit supply are major factors for bubble formations. Macroprudential instruments like limits on loan-to-value ratios should be driven down when the prices in the real estate market increase at a more rapid pace (Allen and Carletti, 2015). On the other hand, it is vital to prevent bubbles through avoiding excessive credit supply.

Arguably, contagion effect mentioned above is one of the most significant problems of systemic risk. However, there are very little understanding on how the spillover occurs and what kind of work could be done to avert this contagion effect. While capital regulations would be the preferred tools for regulators to address the problem of contagion, we do not see much have been done in the Basel agreements in this regard (Allen and Carletti, 2015).

Banks in general are able to receive cheap funds guaranteed by the central bank. The incentives for banks to be more exposed to risks are enticing as taking up risks in loans would pay off on the upside and the losses are covered by the government when things go south. These incentives

need to be offset by a strengthened capital requirement to make sure that banks and their shareholders would also suffer from losses whenever the loans do not perform well. The capital requirement imposed by the Basel agreements also build up banks' resilience to shocks and hopefully effectively reduce the risk of contagion (Allen and Carletti, 2015).

Most importantly to this paper, procyclicality is regarded as one of the major reasons of the cause of current financial instability and the amplifier of the financial shocks. As regulations suggested in Basel II were suggested to be procyclical, the Basel Committee decided to upgrade their regulations, but there was apparently a trade-off between a capital requirement and the minimization of procyclicality (Basel Committee on Banking Supervision, 2009).

The Basel II was criticised to be focusing on individual bank's financial wellness by minimizing its default probability to strengthen the resilience of one single bank. Because of this focus, the Basel II was considered as a microprudential regulation where it concentrated on individual bank's security and put very minimal emphasis on overall financial system, its interconnectedness. Moreover, banks had even the incentive to becoming one of the "too big to fail" or "too interconnected to fail" financial institution because of the bailing-out mechanism by the governments during financial distress. This caused even more negative externalities to the financial markets and put stresses on systemic risks being crystallised (Schwerter, 2011).

As scholars have identified the sources of systemic risks like size, interconnectedness and procyclicality, the macroprudential view has called upon international cooperation and more transparency (increased accounting disclosure requirements), as these factors do not just stop at national level, but rather transcend beyond boarders. Consequently, these financial institutions are required to be regulated internationally. Thankfully, Basel III has achieved a gigantic leap in terms of international coordination, by having at least 27 member states of the Basel Committee to agree to implement the Basel III framework.

In order to deal with the abovementioned issues, regulators have designed a series of macroprudential regulations in the aim of settle the identified sources of systemic risks in a relatively well manner, and to link macroprudential regulations more jointly with microprudential regulations, as the former has an objective to promote soundness of the whole financial system (handling systemic risks), while the latter has the goal to protect individual banks. And it is

considered to be hazardous when banks capital requirement have taken only interests of individual banks themselves in mind and banks can effortlessly increase capital to asset ratio and create liquidity by selling assets or reduce their supply of credits, and these actions cause strong negative externalities to other stakeholders in the financial system, which would result in fire sales and credit crunches (Freixas, Laeven & Peydró, 2015).

The Basel III framework was regarded at an "incentive-based" regulation (Schwerter, 2011). The banks would have a strong incentive to assess their credit portfolio more frequently and make investment decisions more prudently than before, as a stronger capital base with an enhanced risk coverage would make sense for banks to be more prudent with their decision making. Moreover, the conversation buffer suggested in the Basel III framework also promote incentives for financial institutions to maintain sufficiently large amount of equity to avoid restriction on dividend or earnings distributions (as equity insufficiently below the capital requirements would trigger a restriction on distribution).

Procyclicality as one of the sources of systemic risk alongside bank size and also interconnectedness, was nonetheless a major address point for Basel III. The treatment for this issue is namely the countercyclical capital buffer, also the major focus of this paper. The challenge received by this buffer is to have the right calibration to identify the prevailing phase of the financial cycle, as there are a bunch of early indicators for the regulators to choose from when most regulators chose to use the Hodrick-Prescott filter as a long-term trend (Schwerter, 2011). Moreover, another major problem of the countercyclical buffer is that banks will have an obvious incentive to exploit regulatory arbitrage by investing a larger portion of their investments in countries where the countercyclical capital buffer is lower. Thus, there exists also an issue and an incentive that countries will tend to lower their respective countercyclical capital buffer due to political justifications in order to maintain international competitiveness, while there could have been a necessity of a higher capital buffer being imposed in these countries. However, on the positive note, the buffer indirectly increases the incentive of international diversification, which lower country-specific risks (Schwerter, 2011). Further information on this topic will be discussed in the following sections.

One of the flaws of Basel III Framework is that it does not address much on the negative externalities caused by interconnectivity of banks, nor any effective proposals towards "too big

to fail", "too many to fail", or the contagion problems as mentioned earlier in this same section. So far, no clear adjustments of the Basel Accord have been proposed to address these specific sources of systemic risks (Schwerter, 2011). Moreover, despite the fact that it was mentioned that international coordination is the major, if not the most important, key to the success in mitigating systemic risks and macroprudential regulations, the countercyclical capital buffer cannot be implemented with joint efforts by countries, but rather on a national sphere due to practicality, as the adjustments and the levels of the buffer take into consideration the economic situation of the countries.

Related Literatures on Procyclicality of Banks

There are several prior studies show indications of procyclicality in lending behaviour of banks. Notably, the 2007 subprime mortgage crisis that outburst in the United Stated feuded by excessive sales of mortgages to support the demand for mortgage-backed securities, which later spread worldwide into a financial crisis in 2008, has drawn much more attention of scholars to the plausibility that procyclicality of banks being the factor of exacerbation, if not the underlying cause, of the last subprime crisis. Excess procyclicality, as referred to the tendency for banks' willingness to provide credits rises in times of robust economic growth and declines during economic downturns, contributes amplifications of macroeconomic fluctuations and thus leads to financial instability (Jeong, 2009).

Although most industries possess cyclical movements in sympathy with the overall economic movements, discussions have been showing that there is a more rapid cyclicality in the banking sector, meaning bank assets, loans and credits tend to grow faster in expansions and contract more rapidly in recessions. As the major credit provider to the economy and also the prime intermediary for central banks to control the supply of money through monetary policies, procyclicality of bank deposits and loans has major and critical effects on the fluctuations and amplifications of macroeconomy (Bliss and Kaufman, 2002). Because of this, the ability of economy to recover from economic downturns will be hindered by banks unwilling or unable to extend credits to support an expansionary monetary policy. "Credit crunches" will result from the reduced tendency of banks providing sufficient loans given the demand and increased effective bank loan rates.

There are a wide range of theories explaining why the banking system is inherently procyclical, including capital requirement, financial accelerator, over-optimism, reduced supervisory toughness, deterioration in the quality of screening technology, etc. (Jeong, 2009).

For example, Bernanke and Gertler explained a possible reason for banks' procyclicality using financial accelerator model in 1990. The information asymmetry exists between borrowers and lenders facilitates the theory that procyclicality is present in bank borrowing. During economic upturns, collaterals in loans are potentially more worthy, thus making loans more accessible to borrowers. In contrast, during recessions, borrowers including the credit-worthy customers with good credits will not be able to get loans or find it difficult to be granted credits because of lower value of the collaterals in information asymmetry. Instead of having all explanations being addressed in this paper, capital requirement will be focused.

The Basel Accord which is developed in the 1988 was the basis for introducing regulatory capital buffers to control banks' exposure to risks. The amendment of Basel II brought policy-makers to pay more attention to the cyclicality of bank capital requirements which could amplify natural fluctuations. Since the capital requirements were dependent on the risk estimates of banks (Internal Rating-Based Approach), which include probability of default (PD), loss-given-default, etc. to give a holistic estimate on aggregate. These risk inputs fluctuated and tended to be lower during periods when economy was doing well thus led to a relatively lower minimum capital requirements per unit of risk-weighted assets under Basel II (Arjani, 2009).

Given lower minimum capital requirements, banks would have an incentive to increase credit supply or purchase more financial assets when the lending conditions during those times where more lenient. Such behaviour was justified by banks wanted to maximise shareholders' profit. However, as banks in financial systems behave similarly, macroprudential risk in the wider sense would increase and high leverage in the financial sector would amplify if a possible materialisation of risks occurred and banks needed to unwind positions to fulfil higher minimum capital requirements under Basel II Accord during financial shocks. The risks would be spilled over the financial system as most of the banks would behave similarly when raising new capital amid recessions were much harder and would cause loan restrictions and liquidations of assets.

Moreover, there had been scholars suggesting the design mechanism of the Basel II Accord had led to possible procyclicality by banks. For example, J.A. Bikker and P.A.J. Metzemakers have investigated 8000 observations of banks from 29 OECD countries and found out that banks tend to provision substantially more during GDP growth is lower (Bikker and Metzemakers, 2004). This tendency promoted an increasing function of riskiness of the banks' portfolio as the business cycle subsequently reverts and a higher possibility of an advent of credit crunch.

These concerns raised by the banks and other regulatory bodies ultimately paved the way of the introduction of countercyclical capital buffer in Basel Accord III. For instance, the buffer was in the hope of encouraging banks to increase capital base above minimum regulatory requirements during economic booms (Arjani, 2009).

The Countercyclical Capital Buffer

The countercyclical capital buffer and the conservation buffer are the two major instruments of Basel III and the Basel Committee to encourage a more resilient financial sector as a whole in regards to procyclicality. The Basel Committee published the guideline – "Basel III: A global regulatory framework for more resilient banks and banking systems" in December 2010, in which the Committee announced enhanced capital requirements in the banking sector promoting capital adequacy and liquidity, including the countercyclical capital buffer concerned in this paper.

The buffer ensures the banks will take account of the macro-financial environment in which banks operate (Bank for International Settlements, 2019). On top of the minimum aggregate capital requirement of 4.5% of Common Equity Tier 1 (CET1), 1.5% of Additional Tier 1 (AT1) and 2% Tier 2 Equity of total risk-weighted assets, the countercyclical capital buffer aims to aid jurisdictions in preparing banks to fund themselves by sufficient capitals (equity) in preparation of economic development.

The following table provides a short summary of minimum capital requirement. Tier 1 common equity (CET1) has to be kept at a minimum of 4.5%. Together with additional tier 1 equity,

total tier 1 equity has to add up to at least 6%. Additionally, Basel III Accord allow requires banks to have a capital requirement of at least 8% of total tier 1 and 2 equities.

Tier 1 (going concern)	Common Equity Tier 1 (CET1)	Sum of common shares (equivalent for non-joint stock companies*) and stock surplus, retained earnings, other comprehensive income, qualifying minority interest and regulatory adjustments	CET1 >4.5%
	Additional Tier 1 (AT1)	Sum of capital instruments meeting the criteria for AT1 and related surplus, additional qualifying minority interest and regulatory adjustments	CET1 + AT1 >6%
Tier 2 (gone concern)		Sum of capital instruments meeting the criteria for Tier 2 and related surplus, additional qualifying minority interest, qualifying loan loss provisions and regulatory adjustments	CET1 + AT1 + Tier 2 >8%

* The standard requires instruments issued by non-joint stock companies to meet a set of criteria to be deemed equivalent to common shares and included in CET1.

Figure I: Summary of minimum capital requirement of banks given Basel III Accord. Source: Retrieved from the Bank for International Settlements (BIS)

Until 2018, only four jurisdictions including Sweden, Norway, Hong Kong and the UK have established an effective countercyclical buffer rate. However, by 2020, more countries like Belgium, France, Germany and Luxembourg will enact a positive countercyclical buffer to the capital requirement of banks residing in these jurisdictions. Therefore, it will be sensible to investigate into the efficiency of the buffer so far in mitigating procyclical behaviour of banks.

The following table provides a summary of the implementation of the countercyclical capital buffer in selected countries.

Date	Norway	Sweden	Hong Kong	The UK
18/06/2015	1.00%			
13/09/2015	1.00%	1.00%		
01/01/2016	1.00%	1.00%	0.625%	
27/06/2016	1.00%	1.50%	0.625%	
30/06/2016	1.50%	1.50%	0.625%	
01/01/2017	1.50%	1.50%	1.250%	
19/03/2017	1.50%	2.00%	1.250%	
31/12/2017	2.00%	2.00%	1.250%	
01/01/2018	2.00%	2.00%	1.875%	
27/06/2018	2.00%	2.00%	1.875%	0.50%
28/11/2018	2.00%	2.00%	1.875%	1.00%
01/01/2019	2.00%	2.00%	2.500%	1.00%
14/10/2019	2.00%	2.00%	2.000%	1.00%
31/12/2019	2.50%	2.00%	2.000%	1.00%

Implementation of the Buffer in Specific Countries

The European Systemic Risk Board (ESRB)

The European Systemic Risk Board is the supervisory board to monitor the financial system in the EU through macroprudential regulations. For the sake of contributing to the mitigation of systemic risks in order to promote a financial soundness to the European Union. The Board issues mandates that give warnings and recommendations about the financial system for the EU member states.

The ESRB believes the capital should be saved up and accumulated when the cyclical systemic risk is evaluated to be rising. The design of the countercyclical capital buffer (CCyB) is deemed by the Board to be effectively reinforce the resilience of the banks in the financial system

during crystallisation of the risks and losses being materialised. The buffer aids to maintain sustainable credit supply and dampen the economic recession.

The European Systemic Risk Board (ESRB) has published "a review of macroprudential policy in the EU in 2017" in 2018, in which the Board gave a comprehensive report on the policy framework and the macroprudential measure's up to date implementation in different countries and jurisdictions.

Within the European Union, almost all Member States have a macroprudential authority in place as required by the Mandate ESRB/2011/3. These authorities are mostly either the central banks of the countries or an inter-institutional cooperation structure (ESRB, 2018).

As being part of the macroprudential policies and regulations, the countercyclical capital buffer has the following settings. In response to recent rapid credit growth, e.g. mortgage and consumer loans, many countries have set up a domestic countercyclical capital buffer rate, benchmarking credit-to-GDP gap mostly.

Beside domestic countercyclical capital buffer, the Article 139 of the CRD grants national authorities the discretion to implement an additional countercyclical capital buffer rate for non-EU countries. Under this circumstance, if the domestic banks operate in such third countries where no countercyclical capital buffer has been imposed nor the buffer is deemed highly sufficient in the eyes of the national authority, the domestic banks will be required to have an institution-specific countercyclical capital buffer (ESRB, 2018).

Sweden

The Finansinspektionen (FI) is the responsible Swedish financial regulatory body. The FI is tasked to amend the countercyclical buffer rate each quarter in accordance with the regulations (FFS 2014:33). The FI will make assessment to determine whether it is necessary to amend the rate. When no changes are deemed to be necessary, the FI's Board of Directors will publish such decision on FI's website.

The countercyclical capital buffer set by Sweden is decided by a qualitative assessment that consists an array of different quantitative factors. On the other hand, the buffer guide written

also by the FI will play a role in the decision making of the buffer but not the most crucial factor. The goal of the quantitative assessment is to assess the cyclical systemic risks according to the FI's website, so as to set the optimal level of countercyclical capital buffer.

Norway

The Norges Bank is the central bank of Norway, who is also the responsible monetary authority responsible for adjustments of the countercyclical capital buffer. Similar to Sweden, the decision (made by the Ministry of Finance) of whether the countercyclical capital buffer will be adjusted will be included as part of the Norges Bank's Monetary Policy Report.

Hong Kong

According to Hong Kong Monetary Authority (HKMA), as of 14 October 2019, the latest applicable CCyB for Hong Kong is 2.0%. The Authority described the buffer as "a mechanism to build up additional capital during periods of excessive credit growth" which is a system-wide risk. The buffer is said to be released when credit cycle reverts for loss absorption and promotion of sustainable lending in subsequent downturn.

The Monetary Authority provided a comprehensive list of reference indicators as of 27th January 2015 that they take into consideration for the determination of the buffer. Examples of these indicators include but not limit to the credit/ GDP ratios and various GDP-related indicators that incorporate the macroeconomic imbalances, as well as other indicators that show bank liquidity, loan level, risk-weighted assets, leverage and profitability on an aggregate level.

Other countries

According to the ESRB, there are other several countries in the European Union implemented the CCyB during periods that are out of the time frame of this study or pending to enact the buffer. The countries include, Belgium (0.5%), Bulgaria (1.5%), Czech Republic (2%), Denmark (2%), France (0.5%), Germany (0.25%), Iceland (2%), Ireland (1%), Lithuania (1%), Luxembourg (0.5%), Slovakia (2%), United Kingdom (2%). The broad application of this macroprudential measure across different countries in the foreseeable future makes it more important to evaluate the said measure's effectiveness.

Related Literatures on the Countercyclical Capital Buffer

According to the official objectives of the CCyB stated by the ESRB, the two main objectives of the CCyB are: "(i) building resilience during the upswing of the financial cycle; and (ii) dampening the financial cycle" (ESRB, 2018). The countercyclical capital buffer is considered to be the major macroprudential measure in the EU to attend to cyclical risks with regards to excessive loan growth. The Basel Committee wishes that the buffer will be able to achieve a minimisation of procyclicality by reducing the cyclicality of the minimum capital requirements and promote a more forward-looking provisioning equity base (Schwerter, 2011). The countercyclical capital buffer may also help to drive up the cost of finance by increasing cost of capital and thus making credit supply more expensive, hence reducing excessive credit growth (Freixas, Laeven & Peydró, 2015).

However, as identified and stated in the report of the ESRB, the countercyclical capital buffer has been receiving waves of concerns and critics on its implementation and practicality. These concerns are, but not limit to, the choices and decisions on which indicators to identify an early signal of the cyclical risk, also the methodology to identify the current phase of the financial cycle, as these estimates will be crucial in determining the necessity of the countercyclical capital buffer and the magnitudes of the buffer.

Both the ESRB and ECB are dedicated in maintaining the proper management of this macroprudential regulation. The ESRB, for instance, publishes guidance and recommendations for the Member States to follow. The national authorities can make use of their published overview on the applications indicators, so as to make sure they are able to appropriately apply the countercyclical capital buffer. Moreover, the ESRB also issue detailed country information on the use of the countercyclical capital buffer.

On the other hand, the ECB has been focusing on this macroprudential instrument so as to better regulate the systemic wide risk within the European Union. The European Central Bank has the authorization to set a higher capital requirement, on top of the countercyclical capital buffer, on specific Member States, after the ECB has reviewed and considered the economic and financial situation of the concerning Member State.

Notably, the buffer instrument has been gaining more attention and brought under the radar, despite the fact that more countries have announced to increase the buffer or having a positive buffer rate for the first time in their own country. There are evidences, according to the ESRB that the financial cycle is turning, as shown in the graph below.

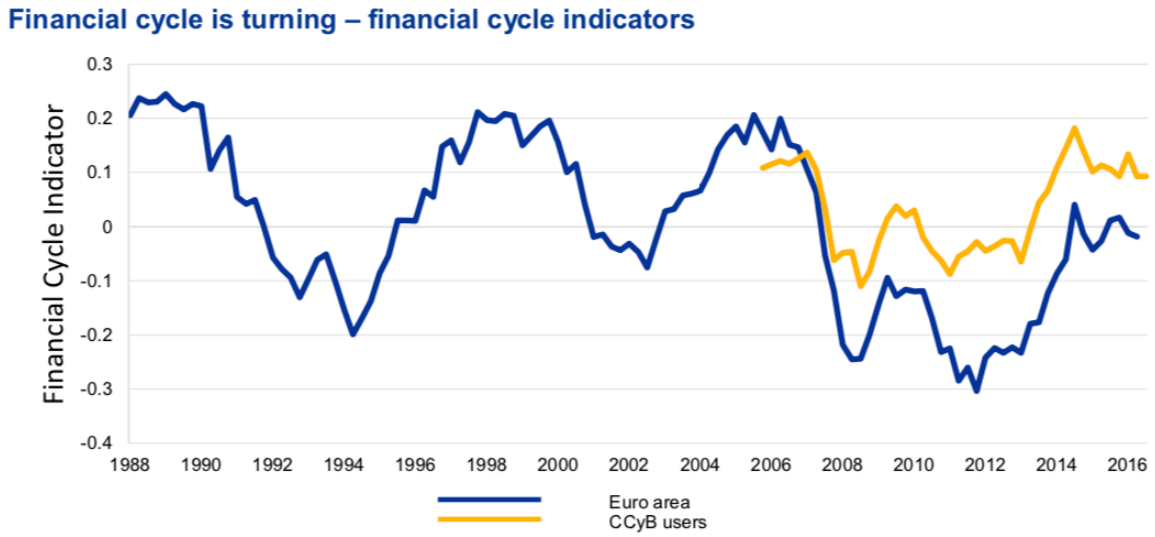


Figure II: Source: Retrieved from European Systemic Risk Board (2017)

As the curves show above, the CCyB users have built up a certain degree of resilience against an imminent financial stress in comparison with the curve concerning the Euro area.

As the countercyclical capital buffer have been introduced through the Basel III Accord, in the aim of dampening procyclicality on bank lending during booms and attenuate credit crunches when buffer is released, Drehmann and Gambacorta have done a backtesting simulation to evaluate the effects of the proposed countercyclical capital buffer on bank lending in 2012 during the time the buffer was first discussed (Drehmann and Gambacorat, 2012).

The idea of Drehmann and Gambacorta (2012) was to simulate increased capital requirements as if the countercyclical capital buffer had been introduced since 1986 on a Spanish bank with a synthesized portfolio as a full representation of the integrated Spanish banking sector. They then passed through the additional capital they added since 1986 into a lending equation oper-

ator that would simulate a new bank lending/ credit supply under the condition that a hypothetical countercyclical capital buffer was introduced. The objective was to see would the supply of credit change under such capital requirements.

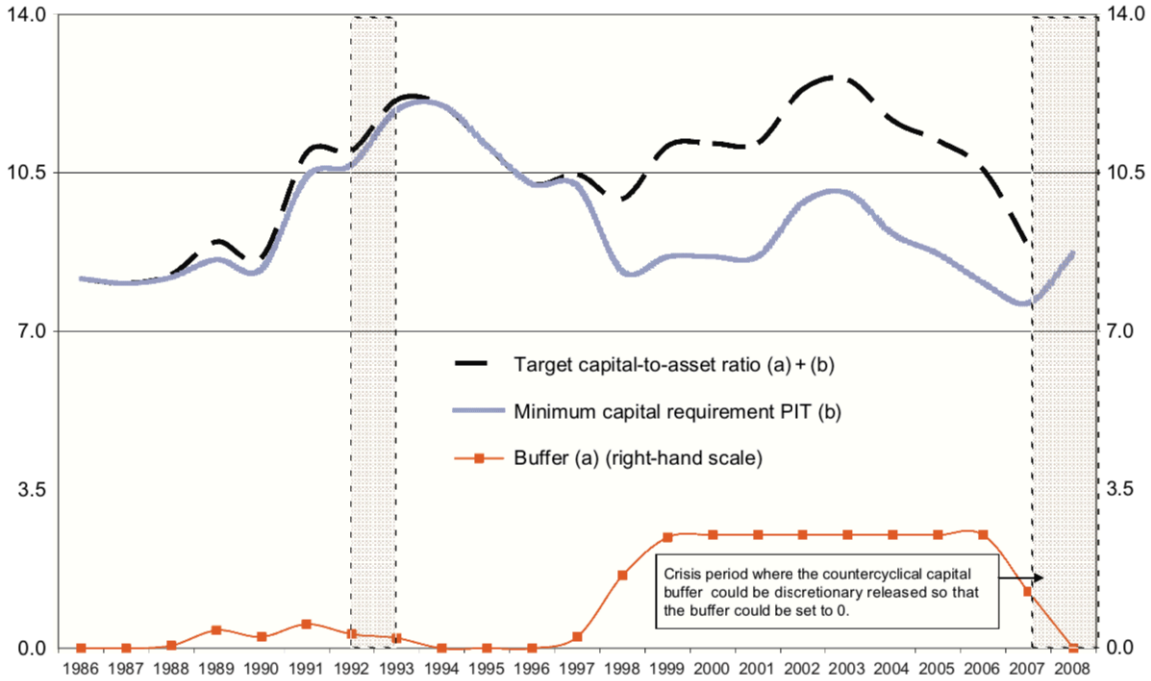


Figure III: Source: Retrieved from Drehmann and Gambacorta (2012).

The results were positive that they were convinced that the countercyclical capital buffer would effectively help to dampen procyclicality of banks. As shown in figure III, it was suggested that the buffer was to be enacted under the backtesting simulation, especially during the 1997-2006 (shown by orange line). The solid blue line showed the effective capital requirement using the actual Basel II minimum capital requirement formula and the dotted line was the simulated minimum capital requirement with the involvement of a hypothetical CCyB and it was obvious that the minimum capital requirement would be higher had the CCyB been introduced during the Asian financial crisis and the dot-com bubble.

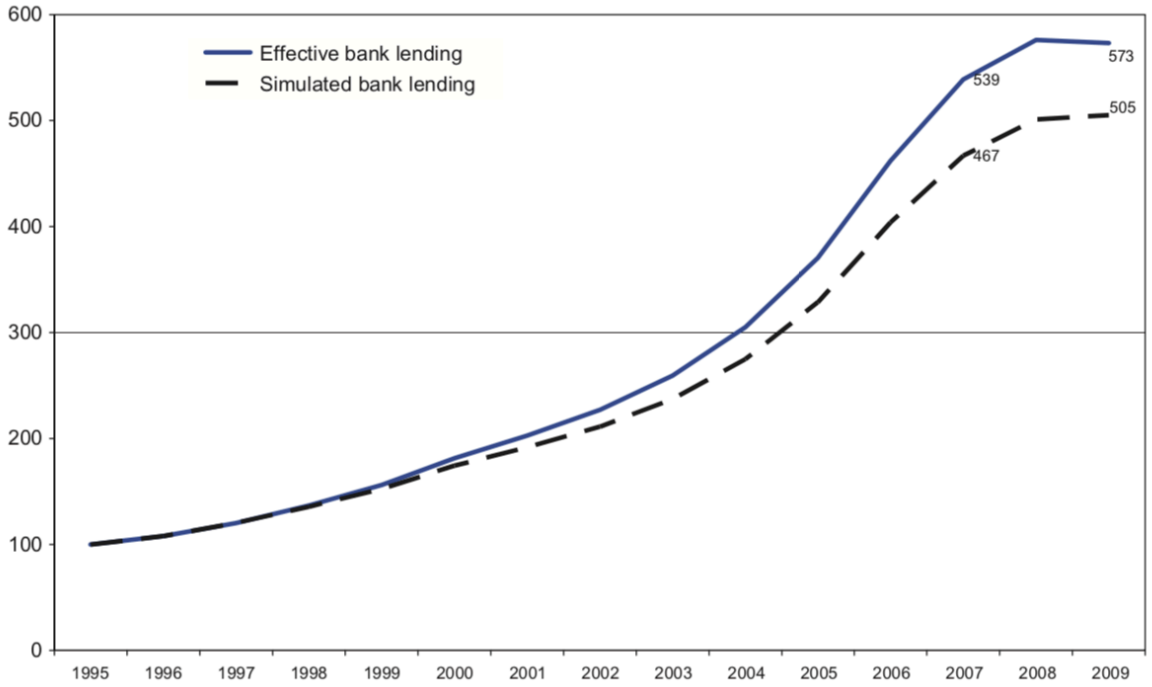


Figure IV: Source: Retrieved from Drehmann and Gambacorta (2012).

From Figure IV, we can see that the simulated bank lending curve was underneath the actual effective bank lending by historical data, which suggested that the countercyclical capital buffer might be as effective as it claimed. However, the scholars in the academic paper have also addressed concerns and uncertainties about the conclusions and results they stated in this paper that had the countercyclical capital buffer really been introduced since the 90s, the banks would have been behaved differently as they had indeed. Second, the lending equation that they used to simulated credit supply was also subject to estimations and statistical constructions. Therefore, the following section using actual data after some countries have indeed introduced the countercyclical buffer might be insightful to see how effective this instrument really is.

Empirical Analyses

Methodology

For this section of the empirical analyses, it is separated into few parts. The first part of the analyses is to prove the existence of procyclicality in echo of the related literatures before. The model specification will be discussed in detail in individual subsection. Second part will be further split into subparts where a different set of data will be used and procyclicality will also be proved. Moreover, the banks involved in this set of data are subject to the impose of countercyclical capital buffer (CCyB) in different countries and in different time frames. Therefore, the effectiveness of the countercyclical capital buffer is meant to be tested in these sections by seeing if the procyclicality in lending behaviour changed significantly. Last but not least, the buffer level is also subject to a test to see whether it is predictable by using the independent variables.

Sample data

In order to reconfirm and investigate the statistical intensity of correlation between changes in supply of loans by banks and business cycle movements, the following section illustrates a regression model referencing a similar empirical study undertaken by Berger and Udell in 2003 where the model regressed annual loan grow rate of banks in the United States against American GDP annual growth rate as a proxy of business cycle.

The remodified model was executed using data from 50 largest banks ranked by total assets in USD in different countries excluding Sweden, Norway, Hong Kong and the United Kingdom where the countercyclical capital buffer has been enacted, in order to serve the purpose as a fair control comparison to the later stage of the regression analysis.

The data range over the period 2005-2018 and they are retrieved from the S&P Global Market Intelligence platform. (Some data points of several banks might be missing due to data availability; some annual reports were too old to be referenced online for public users.) All company/ bank data were retrieved from their company's balance sheets, which are made available on S&P Global Market Intelligence. The real GDP growth rates of the country were retrieved from World Economic Outlook Database. The buffer rates were found on Bank for International Settlements (BIS).

The following regression includes various control variables in the hope of increase explanatory power of the model to the changes in the demand and supply of credits in the financial system. Other possible factors that deem to have an influential effect to the annual growth rate of loans were added to the model as control variables.

The sample data have been tested for absence of multicollinearity as well, with reference to the correlation matrices attached in Appendix II, all of the variables, except for variables that concerned with buffers (which are not used in the same model), have no high correlation coefficient. This eliminated the problem of error that might be brought by multicollinearity.

The following tables show a summary of the data. The Model I's data comprised of the 50 banks excluding the countries with the countercyclical capital buffer, while the Model II's data included the commercial banks from Norway, Sweden and Hong Kong ranging from 2005-2018. The number of observations of the models are specified underneath the respective empirical results in the following sections.

Model I

	mean	s.d.	min	max
loang	0.0910	0.1281	-0.3306	1.3233
rgdpg	3.8328	4.0425	-8.2690	14.2000
roe	11.4063	7.9989	-21.5002	41.1247
lagea	7.2063	8.4783	-13.7141	67.9268
margin	1.9021	0.9138	-0.2635	4.8534
losspro	0.7018	0.7121	-0.5349	5.8686
logassets	20.2677	1.3011	15.3187	22.1164

Model II

	mean	s.d.	min	max
loang	0.1016	0.1551	-0.3359	1.8382
rgdpg	2.4776	2.1899	-5.1960	7.3880
rgdpgm	-0.3963	2.1068	-7.2079	3.9801
buffer	0.3976	0.6715	0.0000	2.0000
dbuffer	0.1741	0.2794	0.0000	0.9167
bufgdp	1.0122	1.7942	0.0000	5.6644
dbufgdpm	-0.0365	0.2670	-0.9224	0.8150
roe	12.1416	6.9112	-19.0492	37.6993
margin	2.0147	1.5906	0.7477	10.1413
lagea	9.0215	3.0837	3.0055	19.6080
losspro	0.3076	0.5177	-1.9240	3.4206
logassets	17.3206	1.6120	13.4686	20.7770

The key exogenous variable

There are a few key exogenous variables in this paper, where *rgdpg*, which is the real GDP growth rate, being the major exogenous variable. It is defined as the proxy of the economic cycle. The focal point of the variable is to see whether there exists a statistical significance between the real GDP growth rate and credit supply growth to prove the procyclical behaviour of banks, as referencing other academic papers. Preliminarily, the scatter plot of *loang* against *rgdpg* showed a linear relationship that fits an OLS regression. (Please refer to the corresponding models where the scatter plots are attached.)

Moreover, the buffer terms are also major foci for this paper. The buffer terms and its interactive terms were added into the models in part 2 of the empirical analyses. The idea was the see

if the significance of the *rgdpg* will be affected after introducing the buffer terms. The significance and the signs of the coefficients of the buffer variables are also of interest. The scatter plots of these buffer terms are also included below in individual subsections.

The last part of the empirical analyses where the buffer is tested against other endogenous variables, the *loang* became one of the exogenous variables instead of being the main endogenous variable.

The key endogenous variables

The key endogenous variable in this paper is mainly the loan growth rate (*loang*), here the loan growth is a measure of credit growth and credit supply change with respect of the preceding year. The interest point mainly is the interaction of the variable *loang* and the other variables, the key exogenous variable *rgdpg* and its related bettered variables, and the control variables, e.g. *roe*.

The Control Variables

The control variables will include factors controlling for bank health, bank size and loan demand. The following models controlled fixed effects for the individual banks, across the period 2005-2018.

The bank health variables include return of equity (*roe*) and lagged total equity per total asset ratio (*lagea*). Bank health has been discussed in prior research that banks with poor financials will reduce credit supply since unsatisfactory financial performance drew pressures from regulators and external stakeholders. Internal parties of banks will also give pressure to replenish capital and avoid banks run into financial distress (Berger and Udell, 2003).

Bank size control variable is represented by the log of total assets (*logassets*). Banks may compete in different loan markets with various conditions depending on the size of their balance sheets (Berger and Udell, 2003). Therefore, the size (or the magnitude of the total assets) seems to be a plausible control variable to be included that will vary the demand and supply of credit.

The control variable concerning loan demand is at utmost importance, as the demand of credit will sensibly be highly correlated to the provision of bank loans by financial institutions, also

annual loan growth. The model selected net interest margin in % to be a representative of bank loan demand, as the profit of banks will indicate also the cost of borrowing of the borrowers and thus the demand of bank loans.

Empirical Study I: The procyclical behaviour of the largest banks by total assets

Empirical study I aims to reassure the existence of procyclical lending behaviour of banks as claimed in other previous academic papers. The following model regressed the annual loan growth rate against a series of independent variables as shown in the following equation below. The first 50 banks over the world by total assets in USD had been picked into the data set. Data were retrieved on the S&P Global Intelligence Platform and their annual reports. Data ranged from 2005 to 2018. (Data in 2019 was not available in the point of this study was completed.)

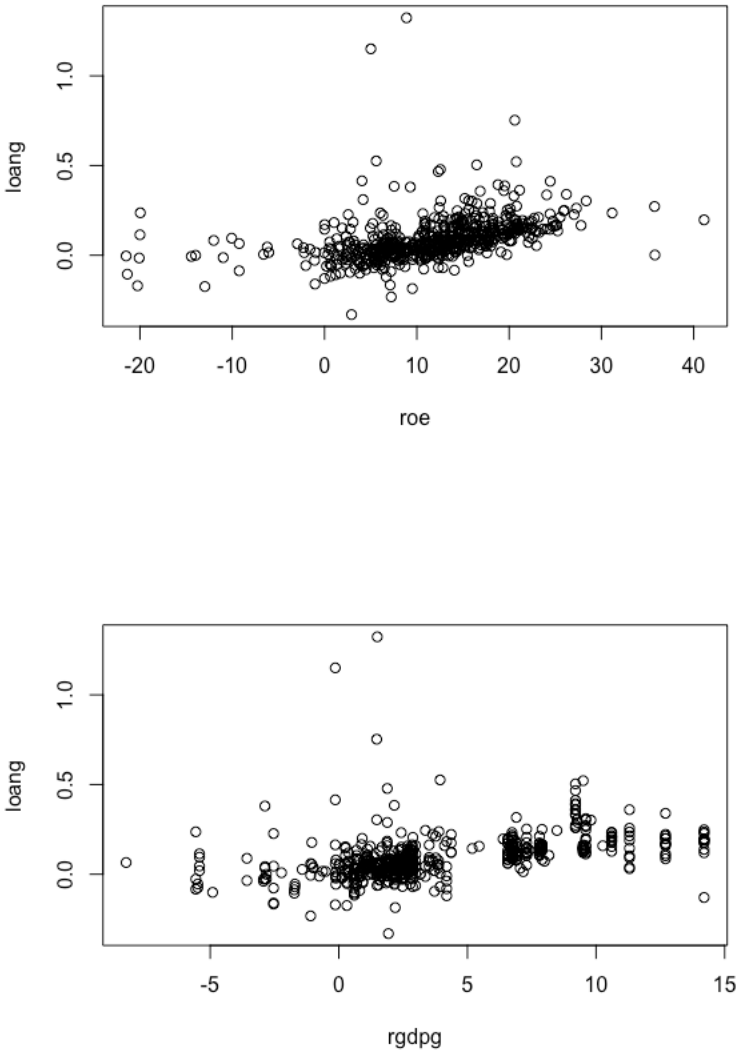
Moreover, out of the 50 banks picked into the data set in this part of the empirical study, the banks residing in countries where countercyclical capital buffer has been in effect, i.e. Norway, Sweden, Hong Kong and the U.K, have been excluded, in order to eliminate the countercyclical effect this paper wants to test in the later parts.

Null-Hypothesis I: $\beta_{rgdpg} = 0$
Alternative-Hypothesis I: $\beta_{rgdpg} \neq 0$

Model I:

$$loang_t = intercept + \beta_{rgdpg,t}\, rgdpg_t + \beta_{roe,t}\, roe_t + \beta_{lagea,t-1}\, lagea_{t-1} + \beta_{margin,t}\, margin_t + \beta_{logassets,t}\, logassets_t + \varepsilon$$

*(Explanations of variables can be found in Appendix I)



Scatter plots of loang against rgdpg and roe

Results:

```
n=580
Residuals:
     Min       1Q   Median       3Q      Max
-0.35979 -0.04897 -0.01564  0.02510  1.26642

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.1833742  0.0793165   2.312 0.021136 *
rgdpg        0.0088926  0.0014546   6.113 1.81e-09 ***
roe          0.0029255  0.0007862   3.721 0.000218 ***
lagea        0.0003823  0.0005634   0.679 0.497680
margin       0.0128808  0.0067467   1.909 0.056737 .
losspro     -0.0059112  0.0077273  -0.765 0.444605
logassets   -0.0090254  0.0038032  -2.373 0.017969 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1123 on 572 degrees of freedom
Multiple R-squared:  0.2398,Adjusted R-squared:  0.2318
F-statistic: 30.07 on 6 and 572 DF,  p-value: < 2.2e-16
```

We can clearly observe that β_{rgdpg} on the above regression analysis summary is 0.0088926 with a p-value significantly small (1.81e-09) at 0.1% significance. Therefore, we can conclude that annual loan growth rate has a high statistical significance on the change of real GDP and reject the null hypothesis.

The coefficient of *rgdpg* is 0.0088926 and the sign of the coefficient is positive, indicating when real annual GDP growth has a positive relationship to loan growth rate. Since we proxy real GDP as the economy, when economy of a country is expanding and the real GDP of that country rises, we can predict there will be an increase in loan growth rate. Banks will be more willing and more able to provide bank loans to borrowers during expansionary economy.

Likewise, when the economy is deteriorating, real GDP of the country declines, the model predicts the availability of loans provided by banks will decrease accordingly as banks are more unwilling to lend money during recessions. We can further conclude that banks tend to lend

when upturns and contract credits, or potentially cause "credit crunches" doing economic downturns when real GDP is lower, proving the lending behaviour of banks is indeed inherently procyclical.

Other control variables provided also some insights. Alongside *rgdpg*, the variable *roe* has also a high statistical significance in the changes of *loang*.

Empirical Study II-A: The procyclical behaviour of banks in the selected countries

Empirical study II-A aims to reassure the procyclicality of banks in these jurisdictions, so that it will be comparable with the ex-post countercyclical effects after the implementation of the countercyclical buffer in part II-B. Secondly, part II-A also serves as a robustness test to test the existence of procyclicality in a different set of banks in other jurisdictions. However, the three countries involved in this part are only Norway, Sweden and Hong Kong. The countries involved in order to serve as a robustness test in comparison to the first part of the study may not be diversified enough.

Nonetheless, the data in the UK will be excluded in this part of the study as it is deemed that it will not be a fair judgement to involve the English banks when the UK has only enacted the buffer since 2018 and only data of one year will be made available.

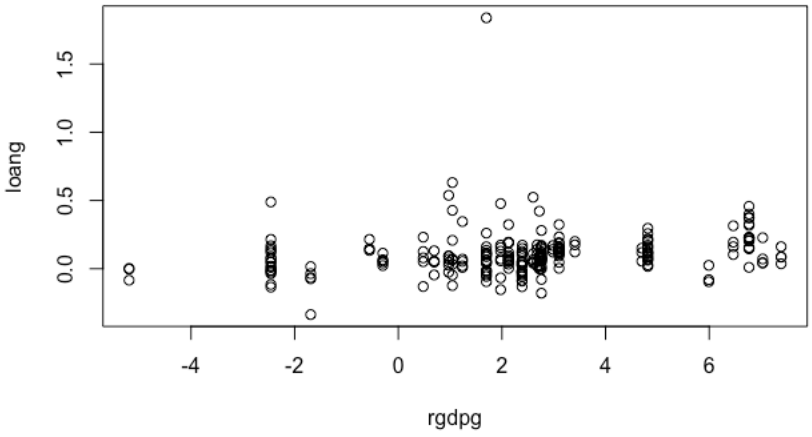
Null-Hypothesis II-A: $\beta_{rgdpg} = 0$

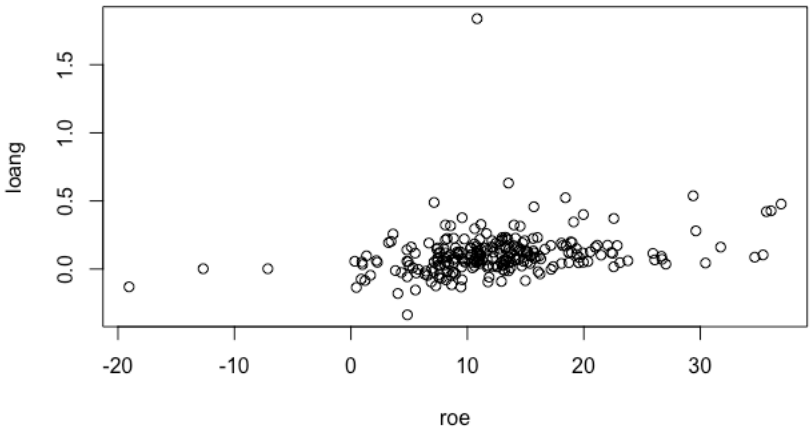
Alternative-Hypothesis II-A: $\beta_{rgdpg} \neq 0$

Model II-A:

$$loang_t = intercept + \beta_{rgdpg,t}\, rgdpg_t + \beta_{roe,t}\, roe_t + \beta_{lagea,t-1}\, lagea_{t-1} + \beta_{margin,t}\, margin_t + \beta_{losspro,t}\, losspro_t + \beta_{logassets,t}\, logassets_t + \varepsilon$$

Results:





```
n=246
Call:
lm(formula = loang ~ rgdpg + roe + margin + lagea + losspro +
    logassets)

Residuals:
     Min       1Q   Median       3Q      Max
-0.31854 -0.07093 -0.01154  0.05133  1.72613

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.0696616  0.1763797  -0.395   0.6932
rgdpg        0.0093902  0.0044843   2.094   0.0373 *
roe          0.0051372  0.0022065   2.328   0.0207 *
margin       0.0190761  0.0160868   1.186   0.2369
lagea        0.0075603  0.0043935   1.721   0.0866 .
losspro      0.0017574  0.0322031   0.055   0.9565
logassets   -0.0005877  0.0093891  -0.063   0.9501
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1569 on 238 degrees of freedom
Multiple R-squared:  0.1568,Adjusted R-squared:  0.1355
F-statistic: 7.374 on 6 and 238 DF,  p-value: 3.009e-07
```

*(Explanations of variables can be found in Appendix I)

From the regression table above, we can observe a p-value of approximately 0.04 for the *rgdpg* variable, which indicates there was indeed a statistical significance at 95% confidence level for said variable. The positive coefficient echoed our hypothesis that the credit growth increases during years when real GDP growth rate is higher, which signals a procyclical lending behaviour as well with the banks in the concerned countries.

On the other hand, the coefficient of ROE was also shown with a statistical significance at 95% confidence level. The results in the study part II-A were comparable with part I where both regressions showed procyclical lending behaviours of banks.

Empirical Study II-B: The changes in procyclicality of banks after the implementation of countercyclical capital buffer

The last part of the empirical analysis investigated the effectiveness of countercyclical capital buffer in mitigating the procyclicality of banks, or, reducing the statistical significance of real GDP growth rate against loan growth rate.

Readjustments of the models including inserting the variable *buffer*. The variable is the weighted average of the level of countercyclical capital buffer in act in the specified country. Besides, an interactive term *bufgdp* was also inserted. Since the level of buffer will be determined by various means used by the central banks or regulatory bodies of those countries, which are highly dependent on the current economic environment, hence also the GDP. Therefore, an interactive term between magnitude of buffer and the real GDP growth rate was also included as an adjustment.

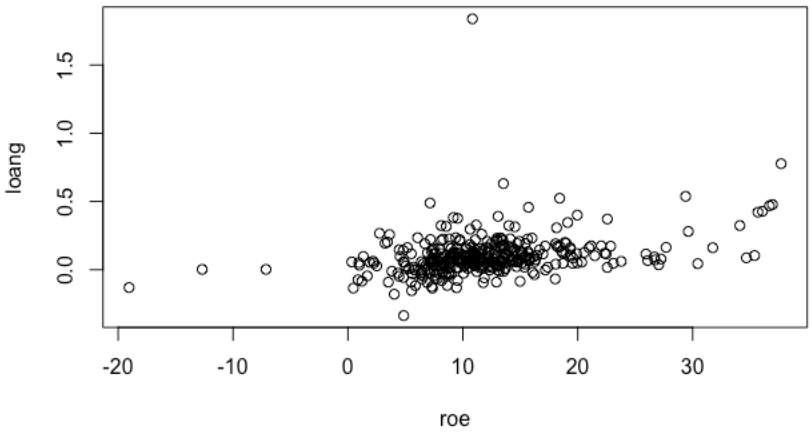
Null-Hypothesis II-B: $\beta_{rgdpg} = 0; \beta_{buffer} = 0; \beta_{bufgdp} = 0$

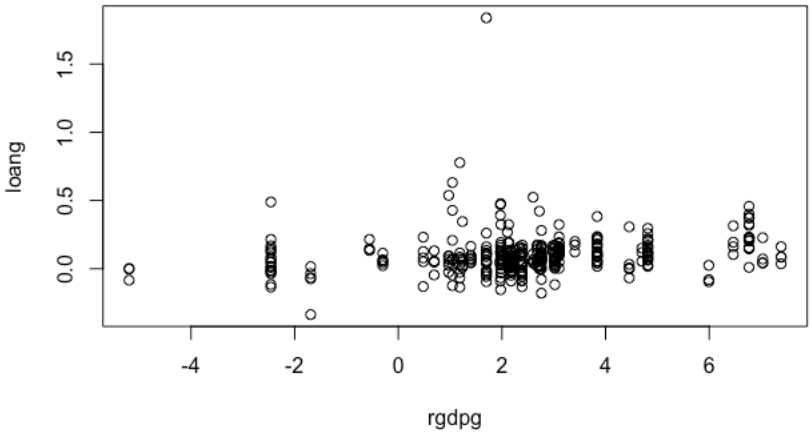
Alternative-Hypothesis II-B: $\beta_{rgdpg,}; \beta_{buffer}; \beta_{bufgdp} \neq 0$

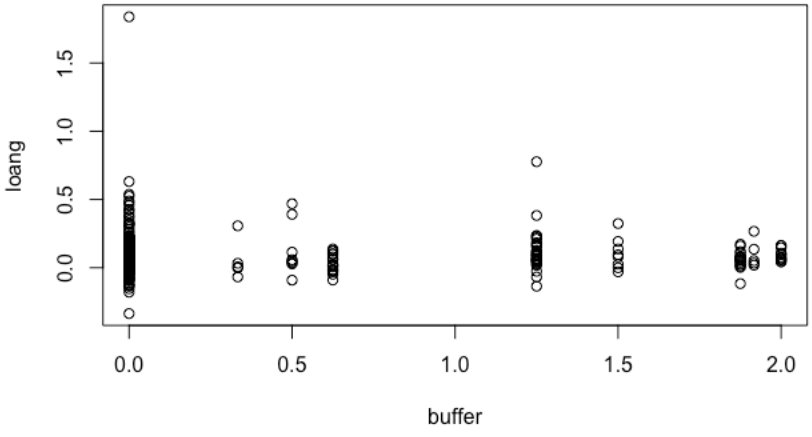
Model II-B:

$$loang_t = intercept + \beta_{rgdpg,t}\, rgdpg_t + \beta_{roe,t}\, roe_t + \beta_{buffer,t}\, buffer_t + \beta_{bufgdp,t}\, bufgdp_t + \beta_{lagea,t-1}\, lagea_{t-1} + \beta_{margin,t}\, margin_t + \beta_{losspro,t}\, losspro_t + \beta_{logassets,t}\, logassets_t + \varepsilon$$

Results:


loang
0.0
0.5
1.0
1.5
-20
-10
0
10
20
30
roe


loang
0.0
0.5
1.0
1.5
-4
-2
0
2
4
6
rgdpg


loang
0.0
0.5
1.0
1.5
0.0
0.5
1.0
1.5
2.0
buffer

```
n=110
Call:
lm(formula = loang ~ rgdpg + roe + buffer + bufgdp + margin +
    lagea + losspro + logassets, data = II2)

Residuals:
     Min       1Q   Median       3Q      Max
-0.16996 -0.04673 -0.00943  0.04071  0.33594

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.358055   0.154196   2.322  0.02226 *
rgdpg       -0.019662   0.023502  -0.837  0.40480
roe          0.008450   0.002946   2.868  0.00504 **
buffer      -0.096917   0.049817  -1.945  0.05453 .
bufgdp       0.046096   0.019225   2.398  0.01835 *
margin       0.007721   0.013929   0.554  0.58062
lagea       -0.006609   0.004563  -1.449  0.15060
losspro      0.039573   0.027484   1.440  0.15304
logassets   -0.017713   0.007562  -2.342  0.02114 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.08851 on 100 degrees of freedom
Multiple R-squared:  0.483, Adjusted R-squared:  0.4416
F-statistic: 11.68 on 8 and 100 DF,  p-value: 1.335e-11
```

*(Explanations of variables can be found in Appendix I)

There are a several takeaways from the results of the final part of the empirical study. Firstly, we can see the p-value of the *rgdpg* rose significantly to 0.40480 as compared to the previous two analyses where both of them show statistical significance in different levels. As real GDP growth no longer contributes to being a significant factor affecting the changes in loans provided by banks or the willingness and ability of banks granting loans, it seems that banks' lending behaviour, to the extent in these jurisdictions, are no longer procyclical. The tendency of banks to lend more during economic upturns and restrict in downturns is inconclusive and not observable in contrast to study I and II-A.

Secondly, the buffer terms are shown to have some statistical significance. The variable *buffer* shows a statistical significance at only 10% significance level with a p-value of 0.05453. Although we can only draw conclusion that the buffer variable has a significant influence on the change on loan provision of banks at a 10% significance level, it has still explanatory power to say that the buffer reduce the statistical significance of real GDP growth as the upon the addition of the buffer term to the model, the p-value of real GDP rose drastically.

The interactive term between real GDP growth and buffer showed a much higher significance at 5% significance level with a p-value of 0.01835. Therefore, we can reject the null hypothesis at a higher significance level and the buffer does influence the changes in loan growth of banks.

Last but not least, we should discuss the coefficient term of *buffer*. The coefficient of buffer is -0.096917 and the sign is negative. The loan growth rate moves in opposite direction against the *buffer* and it is agreeable with our hypothesis and the aim of implementing the countercyclical capital buffer. As when the regulator increases the level of the buffer, the supply of loan will decrease.

Nonetheless, the profitability variable *roe* remains to be significant to the changes in loan growth rate.

Empirical Study II-C: Betterments to Model II-B

Since the two buffer terms do not have corresponding signs, adjustments have been made to the model II-B. In model II-C, the *rgdpg* was replaced by *rgdpgm* where the original *rgdpg* was subtracted by the arithmetic average of GDP growth rate across the periods (2005-2018). Nonetheless, the buffer terms were also replaced by *dbuffer* and *dbufgdpm*, which were the difference (increase/decrease) in buffer level in comparison to preceding year and its multiplication term with the *rgdpgm*. The adjustment to the multiplication term aimed to take away the explanatory effects of the real GDP growth in the interactive term so as to make the sign of the coefficient possibly consistent.

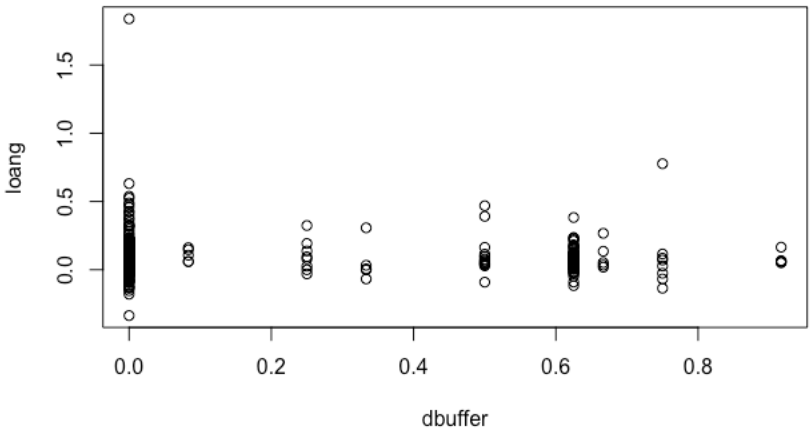
Null-Hypothesis II-C: $\beta_{rgdpgm} = 0; \beta_{dbuffer} = 0; \beta_{dbufgdpm} = 0$

Alternative-Hypothesis II-C: $\beta_{rgdpgm}\,;\, \beta_{dbuffer};\, \beta_{dbufgdpm} \neq 0$

Model II-C:

$$loang_t = intercept + \beta_{rgdpgm,t}\, rgdpgm_t + \beta_{dbuffer,t}\, dbuffer_t + \beta_{dbufgdpm,t}\, dbufgdpm_t + \beta_{roe,t}\, roe_t + \beta_{lagea,t-1}\, lagea_{t-1} + \beta_{margin,t}\, margin_t + \beta_{logassets,t}\, logassets_t + \varepsilon$$

Results:




```
Call:
n=110
lm(formula = loang ~ rgdpgm + dbuffer + dbufgdpm + roe + margin +
    lagea + losspro + logassets)

Residuals:
     Min       1Q   Median       3Q      Max
-0.20616 -0.04390 -0.00738  0.03349  0.32982

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.170276   0.128601   1.324  0.18850
rgdpgm      -0.110203   0.046496  -2.370  0.01970 *
dbuffer      0.093887   0.050914   1.844  0.06814 .
dbufgdpm     0.277374   0.083942   3.304  0.00132 **
roe          0.007768   0.002871   2.706  0.00802 **
margin       0.010075   0.013684   0.736  0.46330
lagea       -0.004904   0.004353  -1.127  0.26261
losspro      0.035056   0.027307   1.284  0.20218
logassets   -0.011993   0.006885  -1.742  0.08459 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.08658 on 100 degrees of freedom
Multiple R-squared:  0.5052,Adjusted R-squared:  0.4657
F-statistic: 12.76 on 8 and 100 DF,  p-value: 1.68e-12
```

*(Explanations of variables can be found in Appendix I)

The variables *roe* and *rgdpgm* remained statistically significant. The higher the ROE, the higher the loan growth rate. However, the sign of the real GDP growth rate reverted. Moreover, according to the results above have achieved coefficients of the buffer variables to have the same sign, which is positive. Both of the buffer terms remained a degree of statistical significance. The positive relationships between the loan growth and the buffer variables hints that the relationship could be inverse meaning the buffer rates are expected to be lifted whenever loan growth is observed to be increasing. Therefore, we would like to see if the casual relationship is inverse in part II-E.

Empirical Study II-D: A completed set of data from II-A & II-C

For the sake of completeness, the following regression results were achieved by incorporating all the data from the 4 years prior to the introduction of the buffer, in order to see if the buffer coefficients will be altered.

Null-Hypothesis II-D: $\beta_{rgdpgm} = 0; \beta_{dbuffer} = 0; \beta_{dbufgdpm} = 0$

Alternative-Hypothesis II-D: $\beta_{rgdpgm}\,;\, \beta_{dbuffer};\, \beta_{dbufgdpm} \neq 0$

Model II-D:

$$loang_t = intercept + \beta_{rgdpgm,t}\, rgdpgm_t + \beta_{dbuffer,t}\, dbuffer_t + \beta_{dbufgdpm,t}\, dbufgdpm_t + \beta_{roe,t}\, roe_t + \beta_{lagea,t-1}\, lagea_{t-1} + \beta_{margin,t}\, margin_t + \beta_{logassets,t}\, logassets_t + \varepsilon$$

Results:

```
Call:
n=355
lm(formula = loang ~ rgdpgm + dbuffer + dbufgdpm + roe + margin +
    lagea + losspro + logassets)

Residuals:
     Min       1Q   Median       3Q      Max
-0.33300 -0.06476 -0.01230  0.05121  1.73425

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.023100   0.122798  -0.188 0.850898
rgdpgm       0.008260   0.003944   2.095 0.036941 *
dbuffer     -0.046808   0.029464  -1.589 0.113047
dbufgdpm     0.019484   0.030986   0.629 0.529894
roe          0.006468   0.001766   3.663 0.000289 ***
margin       0.008643   0.011516   0.750 0.453473
lagea        0.007860   0.003314   2.372 0.018246 *
losspro      0.019244   0.024358   0.790 0.430037
logassets   -0.002075   0.006580  -0.315 0.752712
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.141 on 345 degrees of freedom
Multiple R-squared:  0.1929,Adjusted R-squared:  0.1742
F-statistic: 10.31 on 8 and 345 DF,  p-value: 5.999e-13
```

*(Explanations of variables can be found in Appendix I)

We can see that only real GDP growth rate and ROE tend to be explaining the changes in the loan growth rate, as well as the lagged E/A ratio. The buffer terms were no longer significant in this part.

Empirical Study II-E: Predictability of the countercyclical capital buffer

Given the above statistical significances and relationships, it is suggested that there might be a predictive relationship between the level of countercyclical capital buffer as well as the GDP loan growth rate. Many countries adopted the mechanism to adjust the buffer using the basis of the difference between the country's credit-to-GDP ratio and its long-term trend (e.g. the Hodrick-Prescott filter) (Lof and Jylha, 2019).

The Basel Gap (the difference) acts an early warning signal of financial crisis suggested by Drehmann et a. in 2010. The early indicator has an important implication for helping policy makers in the determination of countercyclical capital buffers. When the Basel Gap indicates an imminent financial crisis, according to the Basel III framework, the regulators would more than likely to increase the capital buffer.

The empirical paper written by Lof and Jyiha in 2019 evaluated the effectiveness of the Basel Gap as an early warning indicator of a financial crisis by comparing the Basel Gap and the credit-to-GDP ratios. The empirical results revealed that the Basel Gap is a nearly equivalent to a simple 16-quarter change in credit-to-GDP ratio. The numerical results showed that the correlation between the two is between 0.82 and 0.96 out of sets of 43 different countries.

It is suspected that based on the construction method of the capital buffer adopted by most of the countries by using the Basel Gap and the correlation findings provided by the empirical results performed by Lof and Jyiha in 2009, the magnitudes or increments of the countercyclical capital buffer could be predictable based on the country's GDP development.

Therefore, given the aforementioned references and the models constructed in previous sections, the amendments are made to contribute the following model where the dependent variable became the buffer itself and the main independent variable observed was the loan growth rate (lagged). The question in mind was to see if the level of the buffer could be explained by the GDP growth and other control variables.

Null-Hypothesis II-E: $\beta_{rgdpg} = 0; \beta_{buffer} = 0; \beta_{lagbuffer} = 0; \beta_{loang} = 0$

Alternative-Hypothesis II-E: $\beta_{rgdpg,}; \beta_{buffer}; \beta_{lagbuffer}; \beta_{loang} \neq 0$

Model II-E:

$$buffer_t = intercept + \beta_{loang,t-1} loang_{t-1} + \beta_{rgdpg,t-1} rgdpg_{t-1} + \beta_{lagbuffer,t-1} lagbuffer_{t-1} + \beta_{roe,t-1} roe_{t-1} + \beta_{lagea,t-1} lagea_{t-1} + \beta_{losspro,t-1} losspro_{t-1} + \beta_{margin,t-1} margin_{t-1} + \beta_{logassets,t-1} logassets_{t-1} + \varepsilon$$

```
Call:
n=78
lm(formula = buffer ~ loang + rgdpg + lagbuffer + roe + margin +
    lagea + losspro + logassets)

Residuals:
      Min        1Q    Median        3Q       Max
-0.188040 -0.032999 -0.008528  0.043973  0.172199

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.754145   0.162833   4.631 1.69e-05 ***
loang        0.053558   0.110607   0.484    0.630
rgdpg        0.105727   0.012359   8.555 2.16e-12 ***
lagbuffer    0.679643   0.024114  28.184  < 2e-16 ***
roe         -0.002939   0.003523  -0.834    0.407
margin       0.014396   0.016372   0.879    0.382
lagea       -0.004717   0.005065  -0.931    0.355
losspro     -0.028135   0.034384  -0.818    0.416
logassets   -0.004426   0.009277  -0.477    0.635
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.09065 on 68 degrees of freedom
  (1 observation deleted due to missingness)
Multiple R-squared:  0.9303,Adjusted R-squared:  0.9221
F-statistic: 113.5 on 8 and 68 DF,  p-value: < 2.2e-16
```

*(Explanations of variables can be found in Appendix I)

From the above regression results, it can be observed that the model has achieved an adjusted R-squared as high as 92.2%, which shows a very explanatory power of the variables to the fluctuations of the buffer rates. The variable *loang*, which is the loan or credit growth shows no statistical significance whereas the variable rgdpg shows, on the other hand, a statistical significance at 99.9% confidence interval. Both of these variables indicated a positive co-

movement with the buffer rate, meaning that as the economy is booming, thus an indication of a possible increment in buffer and an imminent recession. Therefore, when the real GDP growth rate of the previous year has increased, it is likely that the buffer will increase.

Moreover, the *lagbuffer* term represented the buffer level of the previous year. It also shows a statistical significance at 99.9% confidence level. Other control variables did not seem to be contributing to a huge part of how the buffer changes by the authorities.

In short, this part of the model somehow agrees that the buffer will be to a certain extent predictable based on the lagged GDP growth rate and the buffer of the preceding year. This is perhaps related to the basis of how and which statistical instruments the regulators use to decide the level of the capital as agreeable by the paper written by Lof and Jyiha.

Limitations of the Study

There are several limitations to be aware of when drawing conclusions on the results of the analyses. First, the data completeness and availability contribute to a huge hurdle to the study. Many data and annual reports of these publicly traded banks or privately-owned banks are not readily available for public user to retrieve, thus, an incompleteness of data throughout the specified time frame of several banks chosen in the study.

Since one of the objectives of the study is to identify the efficiency of countercyclical capital buffer in mitigating the severity of procyclical lending behaviour of banks. It is important to collect enough evidence to prove that there are effects of this macro-prudential regulation on reduction of procyclicality in lending. However, the data are limited by the number of banks where the jurisdictions the banks reside in, where the countercyclical capital buffer has been enacted as part of the capital requirement. Therefore, the data concerning the buffer in empirical study II is limited.

Moreover, since the time span of the duration that countercyclical capital buffer has been enacted in these jurisdictions ranges only from 3 to 4 years, the period is not long enough to cover both economic expansion and recession, i.e. not a length of a full economic cycle. Therefore, it will be clearer if further studies will be made with data compose of a full economic cycle in order to draw a more certain conclusion on whether the buffer is effective in eliminating procyclical lending behaviour.

Conclusion

From the various models above, this paper would like to draw the following conclusions. First, there exists a procyclical lending behaviour in banks above the minimum capital requirement as proved by Berger and Udell's paper in 2004 and the model I and II-A in this paper. The loan growth rate and thus its supply tend to be higher when the real GDP growth rate is higher. Therefore, the implementation of a macroprudential instrument as an add-on to Basel II regulations is justified as this procyclicality potentially adds towards a source of systemic risk as discussed in the literature review sections.

For the sake of mitigating the increased systemic risks posed by the procyclicality of banks' lending behaviour that will dampen the economic cycles had the risks and financial shocks been materialised, the Basel III Accord introduced the tool of countercyclical capital buffer hoping to ease the concerns of the central banks and the scholars of the existing procyclical effects.

That being said, these regression models undertaken in this paper could not show a significant effectiveness of the countercyclical capital buffer in mitigating the procyclicality of banks. In model II-C, the buffer terms were found to be positively correlated with the loan growth rate with a certain degree of statistical significance, meaning that whenever the buffer term is increased, the banks did not seem to have the incentive to cool down excessive credit growth in the sake of prudence. One of the possible explanations could be that, banks seemed to be willing to take on more risks even when capital requirements increase over time and since losses are usually bail-out by the government, the banks paid equal attention to the risk of providing more credits when capital requirements increase.

Yet, in model II-E, it was deduced that the buffer level set by the regulatory bodies is highly predicative with an extremely high adjusted R-squared and high correlation between the buffer rate and real GDP growth rate, as well as buffer rate enacted of the preceding year. In the same regression model, we could also see that there was no statistical relationship between loan growth rate and level of buffer, suggesting that the positive correlation shown in part II-C could be explained by the explanation in the previous paragraph. Therefore, although Drehmann and Gambacorta (2012) suggested in their backtesting simulation that the CCyB might be effective

in mitigating procyclicality problem, the sample data after the actual implementation of the buffer here did not correspond to the conclusion that they drew in 2012.

Combining the observations with model II-C and II-E, I would like to sum up that the buffer perhaps does not effectively mitigate the growth in credit supply as we hope, as the signs of the coefficients are positive and the model II-E did not seem to show an inverse relationship that the loan growth rate last year has a predictive power of the buffer rate next year.

However, due to the limitations of the study mentioned in the previous section, it is highly possible that a more precise conclusion or comprehensive regression analyses could be done given a longer implementation period of the countercyclical capital buffer with more countries involved. As more jurisdictions have enacted a positive countercyclical capital buffer due to higher growth in credit supply, we can expect more data would be available in the coming years for a more sophisticated empirical analysis on this topic.

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Appendix I – Legend

Variable	Explanation
loang	Net commercial loan annual growth rate
rgdpg	Real annual GDP growth rate by WEO
rgdpgm	Real annual GDP growth rate minus average of GDP rates over the period
buffer	Weighted average of buffer effective in corresponding year of corresponding jurisdiction
bufgdp	Interactive independent term by multiplying *rgdpg* and *buffer*
dbuffer	Difference of buffer between T=t and T=t-1
dbufgdpm	Interactive term by multiplying *dbuffer* and *rgdpgm*
lagbuffer	Buffer level of previous year
roe	Return on average equity; net profit as a percent of average equity (%)
lagea	Total equity/ total assets (%) (lagged)
margin	Net interest income, on a fully taxable-equivalent basis if available, as a percent of average earning assets.
losspro	Provision for customer loan losses as a percent of average net loans to customers held at amortised cost
logassets	Natural log of total assets in USD

Appendix II – Correlation Matrices

Model I

	loang	rgdpg	roe	lagea	margin	losspro	logassets
loang	1.00000000	0.43394971	0.40609274	-0.05422559	0.28590499	0.00453429	-0.2075857
rgdpg	0.43394971	1.00000000	0.57308334	-0.15904182	0.39215020	0.07824596	-0.2086088
roe	0.40609274	0.57308334	1.00000000	-0.08494298	0.45166331	-0.06984737	-0.2277704
lagea	-0.05422559	-0.15904182	-0.08494298	1.00000000	-0.04042781	0.02172464	0.1630261
margin	0.28590499	0.39215020	0.45166331	-0.04042781	1.00000000	0.41476254	-0.1753095
losspro	0.00453429	0.07824596	-0.06984737	0.02172464	0.41476254	1.00000000	0.1141455
logassets	-0.20758569	-0.20860885	-0.22777040	0.16302611	-0.17530950	0.11414554	1.0000000

Model II

	loang	rgdpg	rgdpgm	buffer	dbuffer	dbufgdp	bufgdpm
loang	1.00000000	0.19219098	0.180920645	-0.045682510	-0.0623773889	-0.03557493	0.09456682
rgdpg	0.19219098	1.00000000	0.892690281	0.018474627	0.0319121666	0.09149250	0.06106846
rgdpgm	0.18092065	0.89269028	1.000000000	0.080195584	0.0552842300	0.08105399	0.20270937
buffer	-0.04568251	0.01847463	0.080195584	1.000000000	0.8159536736	0.93474620	-0.15162465
dbuffer	-0.06237739	0.03191217	0.055284230	0.815953674	1.0000000000	0.79820902	-0.26844602
bufgdp	-0.03557493	0.09149250	0.081053993	0.934746204	0.7982090176	1.00000000	-0.11996572
dbufgdpm	0.09456682	0.06106846	0.202709372	-0.151624654	-0.2684460187	-0.11996572	1.00000000
roe	0.34536836	0.19274798	0.250357323	-0.067986367	-0.0961357207	-0.09910607	0.10229206
margin	0.34608753	-0.03745588	0.070608124	0.111217272	0.0752293194	0.05409962	0.10993374
lagea	0.12941041	0.15995459	0.004927379	0.270126063	0.2694274678	0.28514680	-0.16486080
losspro	0.18019269	-0.24496172	-0.186889381	0.064716526	0.0566598530	0.01894935	0.01324003
logassets	-0.10348618	0.11716514	0.025538058	-0.009686247	-0.0009071869	0.05112329	-0.06277131

	roe	margin	lagea	losspro	logassets
loang	0.34536836	0.34608753	0.129410411	0.18019269	-0.1034861807
rgdpg	0.19274798	-0.03745588	0.159954590	-0.24496172	0.1171651365
rgdpgm	0.25035732	0.07060812	0.004927379	-0.18688938	0.0255380576
buffer	-0.06798637	0.11121727	0.270126063	0.06471653	-0.0096862474
dbuffer	-0.09613572	0.07522932	0.269427468	0.05665985	-0.0009071869
bufgdp	-0.09910607	0.05409962	0.285146802	0.01894935	0.0511232884
dbufgdpm	0.10229206	0.10993374	-0.164860801	0.01324003	-0.0627713142
roe	1.00000000	0.47838505	-0.194090105	0.14795540	0.1832658915
margin	0.47838505	1.00000000	0.378432081	0.70774892	-0.4546892200
lagea	-0.19409011	0.37843208	1.000000000	0.19374806	-0.5020542197
losspro	0.14795540	0.70774892	0.193748058	1.00000000	-0.2623271952
logassets	0.18326589	-0.45468922	-0.502054220	-0.26232720	1.0000000000

Abstrakt

Stilisierte Fakten in der Wissenschaft zeigen, dass das Kreditvergabeverhalten von Banken prozyklisch ist, was häufig als bedeutender Faktor bei der langsamen Konjunkturerholung nach der Finanzkrise im Jahr 2008 gesehen wird. Aus diesem Grund beinhaltet ein Teil der Maßnahmen des Basel-III-Abkommens die Einführung eines makroprudenziellen Instruments, das als antizyklischer Kapitalpuffer (countercyclical capital buffer, CCyB) bezeichnet wird. Unter Bezugnahme auf mehrere empirischen Studien hat diese Arbeit das empirische Modell neu gestaltet, um die Robustheit der Prozyklizität zu testen, und das Argument der Prozyklizität von Banken bestätigt, indem eine starke Korrelation zwischen Kreditwachstum und Konjunkturzyklus (oder BIP-Wachstum) zeigt. Nachfolgend zeigte die Analyse der Wirksamkeit der Implementierung des antizyklischen Kapitalpuffers, dass eine starke positive Korrelation zwischen der Größe des Puffers und dem Wachstum des Kreditangebots besteht, was darauf hindeutet, dass der antizyklische Kapitalpuffer die Prozyklizität möglicherweise nicht so wirksam dämpft wie gewünscht. Darüber hinaus deutet einiges darauf hin, dass das Pufferniveau tatsächlich durch die wirtschaftliche Lage des Landes (z.B. BIP-Wachstum) und das Pufferniveau des Vorjahres vorhersehbar ist.

Schlagwörter: makroprudenzielle Vorschriften, Prozyklizität, antizyklischer Kapitalpuffer, Basel, excessives Kreditwachstum

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