ABSTRACT

Unintended Consequences of Well-Intended Regulation: The Procyclical Effects of the Basel I Capital Regulations on the U.S. Banking Industry

Austin T. Hubbert, M.S.Eco.

Mentor: David VanHoose, Ph.D.

Numerous solutions have been posed to address the risks that fractional reserve banking systems cause for depositors. The newest regulatory trend to combat these issues has been capital regulation. Many critics have accused capital regulation of increasing the natural procyclicality of bank loan supply. However, to date the literature appears to say little on whether or not the Basel I capital regulations have any effect on the natural procyclicality of bank loan supply. To test this, I constructed a new loan supply function to determine the relationship between the business cycle and the real loan supply. A Chow Test was then conducted to determine whether this relationship changed at the date of Basel I implementation. I found that this relationship increased significantly after the implementation of Basel I, allowing me to conclude that the Basel I capital regulations increased the natural procyclicality of bank loan supply.

Unintended Consequences of Well-Intended Regulation: The Procyclical Effects of the Basel I Capital Regulations on the U.S. Banking Industry

by

Austin Hubbert, B.B.A.

A Thesis

Approved by the Department of Economics

____
Charles North, Ph.D., Chairperson

Submitted to the Graduate Faculty of
Baylor University in Partial Fulfillment of the
Requirements for the Degree
of

Master of Science in Economics

Approved by the Thesis Committee

____
David VanHoose, Ph.D., Chairperson

____
James West, Ph.D.

____
Allen Seward, Ph.D.

Accepted by the Graduate School

May 2018

____
J. Larry Lyon, Ph.D., Dean

Page bearing signatures is kept on file in the Graduate School.

TABLE OF CONTENTS

Contents

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

I would like to thank my mentor, Dr. VanHoose of Baylor University for his instrumental guidance. This paper would not be anywhere near where it is now without his support.

DEDICATION

To Katherine

CHAPTER ONE

Brief History of the U.S. Government's Role in the Banking Industry

Origins of the Banking Industry

Banking is an ancient trade that can trace its origins back to Assyria, ancient Greece, and Ancient China. There were always groups of people who desired capital and others paid fees to store monetary assets in the vaults of goldsmiths and silversmiths. However, the rise of Christianity (and later Islam) posed a problem to the banking industry, because their religious teachings forbade charging interest on loans. Followers of Judaism, however, were not bound by such teaching. As such, Jews found a successful niche in the banking industry and dominated the practice of lending money across Europe and the Middle East for centuries.

This status quo began to shift during the Italian Renaissance. In one of the first cases of the government extending public debt to its citizens since ancient times, in 1156, the bankrupt Doge Vital Michel of Venice forced the richest citizens in domain to extend loans to his government at approximately 4 percent interest. From the 1150s to the 1550s, lending and deposit-taking institutions such as the Bank of Venice, the Bank of St. George, and the Bank of Naples began opening up across Italy as kingdoms needed funds to finance their endless wars and the growing class of wealthy citizens sought safe places to store their wealth. While moderately successfully, these banks suffered from the constant debasement of medieval currency and attacks from angry mobs such as during

Mansaniello’s insurrection in 1647. Thus, while resembling modern banks, these banks did not enjoy the relative stability known by modern banking systems.

The discovery of the New World and the wars of colonization that followed brought government and banking even closer together. As the initial influx of New World bullion began drying up, European governments were left scrambling to raise funds to expend and protect their nascent empires. Thus, fledgling central banks such as the Bank of England in 1694, the Bank of Spain in 1782, and the Bank of France in 1800 arose to enable governments to rapidly raise funds from their subjects. While the central-bank solution helped fund colonial expansion, it also, perhaps inadvertently, tied the success or failure of governments to the success or failure of their banking systems.

The problems with such an arrangement are as old as banking itself. The ancient goldsmiths who stored people’s monetary assets understood that not everyone desired withdraw their funds at the same time. Thus, the goldsmiths could lend or invest the stored funds and earn a positive return before returning the original principle back to the owners. This system, known as fractional reserve banking, was still used by the newly founded central banks. While fractional reserve banking allowed the banks to move funds from lenders to borrowers and thus stimulated economic growth, it also meant that banks could run out of funds if enough lenders desired their funds at the same time. If depositors begin to lose confidence in a bank and began to withdraw their funds, that bank would appear even weaker, causing more depositors to withdraw their funds and so on, causing the bank to collapse. If this happened, the government would be unable to raise funds and economic growth would grind to a halt.

Governments have tried many different regulatory techniques to avoid this fate, but periodic banking panics (and even collapses) occurred in developed nations into the 1900s. From this point on, I will focus on how banking developed in the United States and how banks and the government attempted to cope with the problems of fractional reserve banking.

Banking in the United States until 1862

While colonists in the Americas had grown used to the more centralized banking systems that existed in Europe, the barter, trading-post, and nascent commodity- and currency-based monetary systems spread across most of the colonies in response to the scarcity of European moneys. The first institution even resembling a bank did not arise until 1671, when John Blackwell established an organization to enable Massachusetts colonists to obtain credit for the purchase of land. Banking continued to grow in the colonies, including the creation of the Land Bank of 1741 in Massachusetts. However, without any regulatory guidance, these banks were highly unstable due to poor management and credit decisions. Indeed, the Land Bank was insolvent by March 1742. This and numerous other banking breakdowns greatly retarded the spread of banking across the colonies, and many colonists grew very distrusting of banks.

This distrust began to fade not by choice but by necessity as the congressional government sought to raise funds quickly in order to fight in the American Revolution. Congress approved Governor Robert Morris's request to charter the Bank of North America on May 26, 1781. While successful in enabling Congress the ability to finance the war efforts, overextension and poor credit decisions weakened the bank by the time the war was winding down. With the threat of British troops no longer looming over their heads, politicians began arguing for the revocation of the Bank's federal charter, which was finally repealed on September 13, 1785. While the bank was able to continue operations (it received a state charter from Delaware on March 3rd 1786), the fledgling American government again had little control over the banking industry.

Banking returned to an industry dominated by small, state banks plagued by limited influence, lack of capital, and mismanagement. With the newly formed U.S. government seeking to raise funds to finance its operations, Alexander Hamilton's idea of the First Bank of the United States was charted by Congress on February 25, 1791. While a fiercely debated issue in congress, Hamilton's bank did make attempts to bring economic stability, including engaging in purchases of U.S. government bonds to prevent their prices from plummeting during the Panic of 1792. Additionally, because businesses and state government state could avoid having to trust an unknown local bank in another state by simply raising capital from the First Bank, this bank's existence contributed to the blossoming of interstate commerce. However, political disagreements led to postponement of the vote to recharter the bank on January 24, 1811, which caused the First Bank's influence to wane rapidly.

This decision arguably proved unwise, because the War of 1812 began the next year, and the government had a very difficult time raising funds without a national bank. This forced the government to issue Treasury notes, an action that increased the money supply and resulted in inflation. These results led to the approval of the Second Bank of the United States by President James Madison on April 10, 1816. While on the surface similar to the First Bank, the Second Bank, under the control of bank President Nicholas Biddle, developed distinct new regulatory functions. By issuing and buying back its notes (which held a similar investiture as any United States Treasury notes), the Second Bank could stabilize a fluctuating money supply. In addition, by expanding credit during down years and contracting credit during prosperous years, Biddle could attempt to stabilize economic development. However, many politicians, especially those allied with newly elected president Andrew Jackson, felt that these powers exceeded those grated by the bank's initial charter. While Congress initially voted to recharter the Second Bank, Jackson vetoed their bill on July 11, 1832 and pulled all government deposits out of the Second Bank. With congress unable to overturn the veto, the bank slowly lost prominence, becoming private and folding by 1841.

Once again, the lack of a central banking institution led to rampant speculation and increases in the money supply as state banks operated with little to no regulatory constraints. A result was the prolonged Panic of 1837, which ushered in the period known as the Free Banking Era. While the Whigs pushed for the creation of a Third Bank of the United States, infighting and Democrat opposition stalled any and all Whig propositions despite the Whigs holding the presidency and congressional majorities in the early 1840's. This allowed a more or less independent U.S. Treasury to take on many new roles, such as financing the Mexican War with treasury notes and restabilizing the money supply by controlling the flow of specie, ushering in a new era for United States banking known as the Independent Treasury Period. Led by Secretary Robert J. Walker, the Treasury could (or at least attempted to) provide the monetary control and reign in the operations of state banks that was previously carried out by the Second Bank of the United States. Despite this fact, state and local banks were still operated under very little regulatory control, and, with the United States government bogged down with the slavery controversy, banking in the United States would remain this way (with slight changed during the panic of 1857) until the outbreak of the Civil War.

Banking after 1862 and the Birth of the Federal Reserve

When the Civil War broke out, both the North and the South were left scrambling to find ways to raise the funds needed to wage war. While both governments attempted to raise funds by selling government securities (a strategy that had always worked in the past), the U.S. banking system was simply too disorganized under the Independent Treasury System (especially in the South) to raise capital in the quantity demanded by the Civil War. Thus, the federal government began encroaching on the freedom enjoyed by the banks. The government first began issuing a fiat money known as greenbacks in a quantity never before issued by the First or Second Bank of the United States. While seen as unconstitutional by some, these actions allowed the federal government to increase the money supply without increasing the supply of specie and thus pay for wartime expenses.

More importantly, the now Republican and former Whig dominated Congresses passed the National Bank Act of 1863 with little resistance. The act set up a national banking system. Banks were allowed to join if they met certain reserve requirements (25 percent for urban banks and 15 percent for rural banks) and received a charter from the Office of the Comptroller of the Currency (OCC). Banks were not forced to join, national banks, having met the requirements set by the federal government, were seen as more financially secure, enabling them to raise funds more easily. The act empowered the government to issue up to $300 million of national bank notes, such as the greenbacks. While the system was not fully implemented until after the Civil War, the National Bank

Act allowed the OCC to stabilize the banking system by only chartering banks that were (or at least appeared to be) financially stable and influence economic activity by expanding or contracting the money supply. However, while the act implemented reserve requirements, it did not outline any forms of capital requirements: a regulatory system requiring that the bank keep a certain percentage of its assets as capital. While inflation persisted after the Civil War due to the substantial increase in the money supply, U.S. banking entered a period of renewed stability, arguably because the OCC could provide a level of banking regulation not experienced since the Second Bank of the United States.

Despite this fact, the decline in the use of Civil-War-era fiat money and the very limited supply of gold caused bank reserves to steadily decline. Without the necessary reserves to extend credit, the loan supply dropped sharply just as the demand for credit increased (due to the autumn harvest), and the Panic of 1873 began. Many of the related monetary and financial problems were caused by a limited supply and unequal distribution of national bank notes. Most of these notes were concentrated in the booming Northeast, while the South and West, lacking both notes and specie, faced shortages of both money and credit. However, with the Civil War inflation still fresh in the minds of many Republican senators, many were reluctant to allow a dramatic increase in money supply within the national banking system. The drawn-out political discussion that followed concerning the power of the OCC and the Treasury to expand the money supply led to passage of the Resumption Act of 1875. This act allowed the OCC to issue more bank notes but only if the Treasury also bought back U.S. notes. However, the act never specified that the Treasury had to buy back the same amount of U.S. notes. The Resumption Act greatly increased the Treasury's power to control the money supply, because the Treasury could buy back more U.S. Notes to decrease the money supply and fewer bank notes to decrease the money supply.

With brief debates about the introduction of silver to augment the gold standard, banking continued in this way for decades until similar problems resulted in the Panic of 1907. Hundreds of banks across the nation failed due their inability to raise capital quickly. In response, Congress passed the Aldrich-Vreeland Act in 1908 which clustered groups of national banks into associations that would essentially serve as clearinghouses, issuing notes to enable the associated banks to stay liquid. To take matters further, the Republicans, led by President Taft, proposed a National Reserve Association Act to set up the National Reserve Administration (NRA) to serve the functions of a national bank. It would be centered in Washington with 15 branches across the country and be owned by the numerous member banks. The hope was that it could provide additional liquidity to member banks as well as provide certain regulatory functions. However, the Republicans were crushed in the elections of 1912 in which they saw Woodrow Wilson elected president and both houses of Congress turn Democratic; the NRA act was tabled.

Now the Democrats too were for reforming the United States banking system, but the American people were too against a central bank (since it appeared monopolistic) for them to take that approach. The Democrats' solution, introduced by Carter Glass of Virginia, was the Federal Reserve Act to increase liquidity in the banking system. Under Glass's bill, the Federal Reserve would be run by eight to twelve regionally-based banks and controlled by the Washington-based Federal Reserve Board. After months of heated Republican opposition, the Federal Reserve Act was passed into law on December 23, 1913.

The Federal Reserve Act was supposed to provide for funding of temporarily illiquid member banks. If a bank was in a financial bind, it could request that the nearest Federal Reserve Bank wire a loan of funds to insure that the bank could meet depositor demands. In addition to these liquidity features, the Federal Reserve System came with certainly regulatory features. If a member bank was struggling, certain disciplinary actions could be taken. Additionally, the ability to acquire loans from the Federal Reserve banks required that a member bank meet certain criteria. Thus, the Federal Reserve Act set up a regulatory apparatus never before seen in the United States in the hopes that a national system could bring stability to an industry that heavily buffeted by repeated panics.

Since the Civil War, the U.S. banking system had evolved from a plethora of independent banks under virtually no regulatory control to the Federal Reserve System, with member banks monitored by the regional Federal Reserve banks and bound by select reserve requirements. The Federal Reserve's oversight did provide some stability to the banking system, but, in the eyes of modern critics, it still left much to be desired. The Federal Reserve only required member banks to meet their reserve requirements without implementing any forms of capital requirements. Banks could thus meet the Federal Reserve's requirements by taking on more debt, greatly increasing the risk of bank defaults. Even worse, there were no guarantees that depositors could get their funds back in the event of a bank defaulting (as the banks only held a fraction of their total deposits as reserves). Thus, while the post-Civil War period saw a large increase in bank regulation, neither the Federal Reserve nor the Treasury in general had any real power to limit the overall risk in the banking system. Banks were able to extend vast amounts of credit in the good times, as they could earn higher returns than they were paying as interest on debt. Very little thought was given to what might happen in less than stellar times, as the economy roared through the golden era of the 1920s. However, these good times were not destined to last forever.

The Great Depression and the Rapid Expansion of Regulation

Even before the Great Depression started in earnest, many observers had already started noticing problems in the banking industry; banks seemed to be making riskier and riskier loans in order to charge higher interest rates and thus keep profits high. Many critics felt that banks faced too much competition from other banks and thus took risky loans to stay afloat. In response, Congress passed the McFadden Act of 1927. This act forced banks with national charters to be bound by state laws when forming new branches. The hope was that, by greatly reducing the amount of banks that could branch across state lines, Bank profits would increase, allowing them to remain profitable while taking safer loans.

However, when the stock market crashed two years later, many banks quickly realized that they were still exposed to too much risk. Hordes of depositors rushed in to withdraw their deposits only to find the fraction of reserves remaining in their banks insufficient to recover their funds. Then, when the banks eventually failed, their deposits were lost for good. Hoping to prevent the repetition of such a horrible scenario for depositors, the federal government enacted Banking Act of 1933 (Glass-Steagall Act) to set up the Federal Deposit Insurance Corporation (FDIC). The FDIC, made permanent by the Banking Act of 1935, insured all deposits in Federal Reserve member banks up to $5,000. Additionally, the act set maximum interest rates on the checking deposits of customers to aid profitability. Thus, the federal government rapidly grew from a bystander to a powerful supervisor of the U.S. banking industry.

The majority of these new regulatory features stayed in place for decades (the Glass-Steagall Act was repealed by President Clinton in 1999). While regulation certainly addressed some of the issues that plagued the banking industry in the earlier period, it brought problems of its own. One problem was caused by the ceilings placed on demand deposit interest rates. If interest rates on financial instruments rose high enough (as they periodically did), savers would pull their deposits out of banks to direct to invest in those securities. However, due to transaction costs, speculation, or other factors, savers only sluggishly returned their funds to banks once the market interest rates fell back down. The result, known as disintermediation, meant that banks could face shortages of deposits and thus have to restrict loan supply due to lack of funds.

In stark contrast from previous solutions to problems in the banking industry, a cry for deregulation had built up by the 1980s, beginning with the Depository Institutions Deregulation and Monetary Control Act (DIDMCA) in 1980. DIDMCA reduced the interest rate caps faced by banks to nothing over a period of six years and increased the FDIC insurance from accounts of $40,000 to accounts of up to $100,000. Additionally, Congress followed suit by passing the Garn-St. Germain Act of 1982. This increased the attractiveness of banks to investors by allowing the use of money market accounts which offered higher interest rates than did demand deposits. The hope was to increase the return and decrease the risk associated with placing savings in banks to reduce the risk of disintermediation.

These measures revealed a deeper problem growing in the banking industry. At the time, banks were all charged the same deposit insurance premium by the FDIC to ensure each dollar of deposits regardless of how much risk to which each bank was exposed. Consequently, a bank could earn increased profits by taking on risker loans (and thus earn higher interest rates) without exposing themselves to additional risk since their deposits would remain fully covered by the FDIC. Banks subsequently carried out this strategy throughout the 1980s, which greatly increased the overall level of risk in the banking system. The government responded to this problem with a two-fold approach. It allowed FDIC regulators to regularly examine banks to ensure they were well-managed and meeting reserve requirements. Banks failing to meet regulatory standards could face fines and other punishments. Additionally, after the Continental Illinois Bank (which was then the seventh largest bank in the nation) almost failed in 1982, the FDIC and the Federal Reserve worked together to bail them out. The OCC cemented this new policy in 1984 by declaring the nation's eleventh largest banks "too big to fail", further exasperating the already rampant moral hazard problem. Thus, mitigating the growing risk problem was the new problem facing federal regulators.

The first attempt to solve this was the FDIC Improvement Act (FDICIA) of 1991. The FDICIA set up the policy of structured early intervention and resolution (SEIR) that enables the FDIC to step in earlier to help member banks that seem likely to fail. Additionally, the act formalized the criteria that banks needed to meet to satisfy FDIC requirements and the responses available to the FDIC in the circumstances that these responses were not met. More importantly, it changed the structure of the FDIC insurance premiums to allow for risk-based premiums. Now, the FDIC was allowed to charge banks exposed to more risk higher premiums than it would to less risky banks. The goal was to incentive banks to take on less risk (to earn lower premiums) while at the same time increasing the size of the FDIC insurance fund.

Despite these attempted solutions, the problem of risk in the banking industry was far from resolved. Banks were still taking on more and more risks to maximize profits while still meeting the FDIC's specific requirements. However, while bank profits boomed, consumers were exposed to more and more risk; risky banks were more likely to fail and thus more likely to lose the savings of their depositors. The United States Banking System needed a new system to decrease the overall risk in the banking system and thus protect the savings of millions of Americans. Since the Great Depression, banking had experience a surge of regulation followed by a wave of deregulation and finally a resurgent wave of regulation. However, the risk problem associated with the banking industry was still as rampant as ever. It was arguable that a new regulatory approach should be contemplated to shield depositors from this risk. The next solution would come from a joint effort between American and European: capital requirements.

Capital Requirements and Basel I

One of the primary drivers behind the growing risk in the banking system is that, since banks could earn more in interest on loans than they paid on deposits, banks could increase their profits by taking on more deposits and subsequently lending them to the point where the marginal revenue from the loans equaled the marginal costs of the deposits. This strategy great increased the debt ratios of banks, meaning that banks had a smaller equity cushion relative to the size of their debt if the economy slumped and their risky loans failed to be repaid in full. To reverse this trend, the government passed the

International Lending Supervision Act of 1983 to allow regulators to impose capital requirements of banks. The Federal Reserve, OCC, and FDIC worked together to set up different capital requirements of the banks under their regulatory umbrella. However, the problem still persisted that banks were all bound by the same capital requirements regardless of how much risk they were exposed to; a bank with most of its investments in government debt was treated the same way as a bank with most of its investments in a third world country on the verge of default. The risk problem would require a more complicated solution.

This solution would come from Basel, Switzerland in 1988, when central-bank and other supervisory officials from the United States and other Western nations met at the Bank of International Settlements to create a system of banking regulations known as Basel I that would affect financial institutions in all of the participating nations. It would take full effect by the year 1993. Basel I, among other things, was the first system of capital requirements that adjusted for how much risk a bank was exposed to by assigning a bank's assets into different risk classes in order to calculate risk-adjusted assets.

Assets that were seen as very safe, such as U.S. Government debt and other debt that was fully guaranteed by the General National Mortgage Administration (GNMA) did not have any weight when calculating risk-adjusted assets. Only 20 percent of assets that were slightly more risky, such as loans made between banks and securities from the Federal National Mortgage Administration (FNMA) would count against a bank's risk-adjusted assets. Certain mortgages were weighted at 50%, and any other type of bank asset would be weighted at 100 percent.

Then, Basel I separated a bank's capital into core capital (Tier 1) and total capital (Tier 2). Core capital would only be made up of common stock and the bank's retained earnings; things that were traditionally seen as capital. Total capital would include all of a bank's core capital plus any preferred stock and subordinated debt held by the bank. Under Basel I, a bank's core capital had to be at least 4 percent of its risk-adjusted assets and total capital had to be at least 8 percent of its risk-adjusted assets. Additionally, a bank's total capital had to be at least 4 percent of its total assets (not risk-adjusted).

The goal for Basel I was to increase the amount of capital held by banks relative to their risk-adjusted assets. For the most part, Basel I accomplished this goal. While many banks initially struggled to meet the new requirements, the amount of capital held by banks increased relative to risk-adjusted assets during the period after Basel I was implemented. However, Basel I may have also led to new problems. Many claim that Basel I, and capital requirements in general, increase the general procyclicality of the industry.

Do capital requirements increase the amount of procyclicality in the banking industry? The issue is still being debated and will be discussed throughout this paper. In the next section, the current literature outstanding on this issue shall be reviewed before beginning deeper analysis on capital requirements and procyclicality.

CHAPTER TWO

Literature Review

Capital Requirements and Procyclicality

Now, before condemning capital requirements, it must be said that banking is naturally a very procyclical industry (VanHoose 2010). When times are good, people have more funds to save, which increases the supply of deposits and thereby generally increases the amount of deposits held at banks. Additionally, in good times both consumers and businesses desire to increase their spending, which increases the overall demand for loans from banks. When consumers need loans, banks have the ability to supply credit due to the increase in deposits, which increases the supply of loans in the economy and thereby boosts bank profits. When times are bad, however, depositors generally will withdraw their funds in order to support themselves during the recessions, decreasing the overall supply of loans from banks. Additionally, consumption and investment decreases during recessions, which decreases the overall demand for loans from banks. Thus, aggregate levels of loans in the economy should typically increase during expansions and fall during recessions.

Additionally, other types of regulation have also been shown to have procyclical effects on bank loan supply. Goodhart, Hofmann, and Segoviano (2004) explain that, during recessions, regulators are much stricter when examining banks due to the heighted risk of default, leading to a general contraction in loan supply. During expansions, however, regulators take a more laissez-faire approach to bank regulation as the risk of default generally decreases. Consequently, banks are freer to increase loan supply. Certain regulatory activities, therefore, can augment the positive relationship between bank loan supply and the overall state of the economy.

Frait and Komárková (2013) examine the quantity of loan-loss provisions of banks from the Czech Republic to figure out the degree of procyclicality in the loan supply of individual banks. These authors find that, as the Czech Republic's GDP increased, Czech banks held fewer loan-loss provisions per dollar, which they argue means that banks tend to loan more during good times and save more (as provisions against potential losses) in economic downturns. Thus, bank loan supply typically displays procyclical behavior.

However, capital regulation has been thought to increase the natural procyclicality of bank lending even more. Ayuso, Pérez, and Saurina (2004) study the capital positions of multiple Spanish banks from 1986 to 2000. They find significant evidence that capital regulations have led to procyclical behavior in bank capital, with capital levels rising during expansions and vice versa. Under Basel I capital regulations, this would mean that banks would be allowed to lend more during expansions (while capital positions are strong) and less during recessions (as capital positions deteriorate), increasing the natural procyclicality of bank loan supply. This fact can pose certain problems. A procyclical loan supply is certainly a good thing while the economy is doing well; loans will be easily obtainable for consumers and businesses looking to invest and interest rates will general fall due to the increased supply of loans. Conversely, a procyclical loan supply tells a much different story during recessions; the loan will be hard to acquire and interest rates will rise due to the restricted loan supply, stifling investment and hampering economic recovery. If capital regulations augmented the natural procyclicality of loan supply, these trends would worsen, increasing the length and severity of economic downturns.

Much research has been done to investigate potential procyclicality effects of the Basel II Capital Regulations, which were published in 2004 by the Basel Committee and were intended to replace the older Basel I framework. Whereas Basel I required the same capital to asset ratios regardless of the riskiness of a bank's assets, Basel II introduced more thoroughly risk-based capital requirements. Thus, more-risky assets counted more towards a bank's capital adequacy ratios. Riskless or nearly riskless assets, such as cash, GNMA mortgaged-backed securities, and U.S. treasury bills still received a weight of 0 percent. While most government securities counted 0 percent under Basel I, government securities now varied in weight based off of the risk associated with that country, such as Mexican government bounds counting 50 percent. Additionally, while all bounds had a 100 percent weight under Basel I, Basel II varied bond weights based off of their credit rating, such as AAA bounds only counting 20 percent (Bakiciol et al, 2008). Thus, banks holding assets that are relatively more risky would have to hold more capital per dollar of assets that banks holding assets that are relatively less risky since the banks with riskier assets face a higher chance of their customers defaulting on their loans.

While these more thoroughly risk-based capital requirements certainly seem beneficial, they also brought certain problems. Many believed such a system would again augment the natural procyclicality of the banking industry. When times are good, nearly every loan can be seen as less risky; both businesses and consumers typically have more funds (or at least easier access to funds), making it easier for them to repay loans and thus lowering their risk of default. Thus, bank assets become less risky and are weighted less when computing the Basel II capital requirements, allowing the banks to increase their amount of loans without changing their amount of capital. However, when times are bad, nearly every loan can be seen as more risky; businesses and consumers are more strapped for cash, making it harder for them to repay their loans and thus increasing default risk. Thus, bank assets become more risky and are weighted more when computing Basel II capital requirements, forcing banks to restrict their loan supplies to satisfy the requirements subject to their risky assets. Thus, capital requirements that loosen during good times and tighten during bad times should reinforce the natural procyclality of the banking industry (VanHoose 2010).

Repullo and Suarez (2013) seek to test the procyclical effects of Basel II and Basel I. They create a model with no capital requirements, a model with Basel I capital requirements and a model with Basel II capital requirements and then use data from US banks for a period before the 2007 financial crisis. They find that, while the Basel I system was slightly more procyclical than the laissez-faire system, the Basel II system produced even more procyclical effects than even the Basel I system. Interestingly enough, they found that the probability that banks fail when times are bad were lower under the Basel II system than either the Basel I or laissez-faire system. Thus, while Repullo and Suarez's study certainly questions the severity of the consequences of procyclicality, it certainly shows that risk-based capital requirements have strongly procyclical effects.

Liu and Seeiso (2012) also study the procyclical effects of risk-based capital requirements, but they use data from South African banks between the years 2003 and

2009. These authors apply the financial accelerator model (BGG) (Bernake et. al, 2009) and place Basel I and Basel II capital requirements within the model. They also find that the risk-based capital requirements under Basel II generally increase the procyclicality of bank loan supply. Additionally, they find that the Basel II system generally makes loan supply more sensitive to monetary policy changes. Thus, Liu and Seeiso's study again shows that risk-based capital requirements typically augment the procyclicality of bank loan supply.

Finally, Bernd Hofmann (2005) uses a model of loan supply to examine the difference in the procyclical effects of the Basel I and Basel II capital requirements. Using data from large German banks from the years 1956 to 1992, Hofmann examines how changes in real German GDP affect change in real loan supply during the period. Hofmann also finds that the Basel II risk-based capital requirements general augment the relationship between changes in real GDP and changes in real loan supply, showing increased procyclical behavior in bank loan supply. However, he also shows that the relationship between capital and the capital requirements determines the magnitude of the increase procyclicality. If capital can rise during recessions, when capital requirements also rise, the procyclical effects of risk-based capital requirements can be mitigated.

Thus, the literature seems to be very clear; risk-based capital requirements such as the Basel II capital requirements should increase the natural procyclicality of bank loan supply. Perhaps capital requirements aren't to be condemned entirely; it certainly makes sense to require depository institutions to hold some kind of capital buffer to protect their depositors during recessions. Most of the problems that the literature raises about capital requirements stems from their risk-based component, with the capital requirements rising during recessions. Nevertheless, the Basel I capital requirements had no such risk-based component. Interestingly enough, the literature is more or less silent on the procyclical effects of Basel I.

Perhaps due to the fact the Basel I has since been replaced, very few studies have looked at the procyclical effects of non-risk-based capital requirements such as those under Basel I. As noted above, Repullo and Suarez (2013) examine the procyclical effects of both Basel I and Basel II capital requirements and find that Basel I capital requirements had procyclical effects but that they were weaker than the procyclical effects of the Basel II capital requirements. Additionally, Ines Drumond (2009) predicts in her theoretical framework that Basel I capital requirements should increase the procyclicality of bank loans supply. While she does reaffirm that the Basel II capital requirements should be more procyclical than those of Basel I, she claims that because capital is generally more costly to generate during recessions, capital requirements increase the marginal cost of increasing the loan supply during recessions. Thus, even non-risk-based capital requirements should have procyclical effects.

It appears that the question still remains whether or not the Basel I capital requirements, which lack the risk-based components of the Basel II capital requirements, truly cause bank loan supply to behave in a more procyclical manner. This is a very important question. Increasing the natural procyclicality of bank loan supply would increase the reduction of bank loan supply during recessions, hurting consumers and businesses alike and retarding economic recovery. The goal of this paper is to examine whether or not the Basel I capital requirements augmented the natural procyclicality of bank loan supply.

Capturing Procyclicality

The main difficulty with this task is finding an empirical measure for the procyclicality of bank loan supply. Procyclicality can be loosely defined as the behavior of oscillating around a given trend as the business cycle progresses, and the increase of procyclicality can be shown as an increase in the magnitude of the oscillations (Landau, 2009). Thus, to determine whether or not the Basel I capital regulations increased the procyclicality of bank loan supply will require a quantitative measure that captures such an increase in the oscillations of bank loan supply.

Mansor H. Ibrahim (2016) attempts to do just that in his study of the Malaysian dual banking system which is comprised of both traditional banks and Islamic banks. Ibrahim tries to determine whether or not the different practices at the Islamic bank help stabilize the bank system during both expansions and recessions: reducing the procyclicality of the banking system. In his model he regressed the first difference of the natural logarithm of real Malaysian GDP (among other covariates) against the first difference of natural logarithm of aggregate real loan supply of Malaysian banks. Thus, Ibrahim attempts to capture the relationship between changes in loans and changes in GPD by constructing a loan supply function and examining the regression coefficient. If this relationship increased, bank loan supply would be more sensitive to changes in the business cycle (increased oscillations around the trend), and thus procyclicality would have increased.

Additionally, Ayuso, Pérez, and Saurina (2004) use data from Spanish banks from the years 1986-2000 in order to determine whether or not the capital buffers held by banks behave in a procyclical way. To capture the concept of procyclicality, they regress the growth in Spanish GDP (among other covariates) onto the capital buffer held by each bank. Thus, similar to Ibrahim's study, this study attempts to study procyclicality by constructing a regression and examining changes in the regression coefficient for changes in GPD.

Finally, Solon, Barsky, and Parker (1994) study how the composition of the sample (low-skilled vs. high-skilled labor) affects the procyclicality of the real wage rate. To do this, they constructed a regression to predict the real wage, using both the change in unemployment and the change in real GDP (among other variables) as covariates. They use the coefficients for both of these variables as to different measures of procyclicality. Thus, while they were studying the procyclical behavior of a completely different variable, they still captured the concept of procyclicality by building a regression and studying the relationship between their variable of interest (in this case, the real wage) and the regression coefficient for some variable that is strongly related to the oscillations of the business cycle, such as real GDP or unemployment.

Thus, the literature seems clear on the best approach to study the procyclicality of the behavior of any variable. One must first find some variable that is related to the variable of interest that is also closely tied to variations in the real business cycle. That variable can then be regressed on the variable of ultimate interest (along with any other necessary covariates), and the regression coefficient for the potentially procyclical variable can be examined. If the coefficient is significant positive, the ultimate variable of interest is procyclical, and if the coefficient is negative, that variable is countercyclical. Significant positive changes in this coefficient would thus represent a significant increase in the procyclical behavior of your variable of interest and vice versa. Thus, for my experiment I must construct a loan supply function and regress some variable that is both strongly procyclical and related to real loan supply (possibly real GPD), and study how the regression coefficient for that variable changes at the start of July 1992, which is the date Basel I standards were fully implemented in the United States.

Determination of Bank Loan Supply

The first step is to find an economic variable that is both related to bank loan supply and the business cycle. Real GDP is a very obvious candidate. In fact, many studies have found significant positive relationships between real loan supply and a nation's real GDP. Jane Bogoev (2009) seeks to determine whether or not she could prove that a bank lending channel existed in the nation of Macedonia, and in her experiment she constructed a bank loan supply function and used real Macedonian GDP as one of her covariates. She found a significant relationship between the real loan supply of Macedonian banks and the nation's real GDP.

Additionally, Rainer Haselmann (2006) conducts an experiment to determine how foreign banks act in transitioning economies. He also constructs a loan supply function for his experiment and used a term named "Demand" as one of his covariates. One of the key factors that determined demand for bank loans in his model was the growth in real GDP. He again found that bank loan supply was significantly related to the growth of a nation's real GPD. It seems that real GDP, or at least the change in real GDP from one period to the next, is significantly related to bank loan supply.

Finally, real GDP simply has to be shown to be significantly related to the business cycle, or to be procyclical. This is quite trivial to show, as real GDP is one of the key determinants to show changes in the business cycle. Some of the primary components of GDP, consumer spending (McCully, 2011), investment (Shinagawa, 2013), and government spending (Brückner and Gradstein, 2014) all behave in a more or less procyclical way. Real GDP should rise during expansions and fall during recessions: real GDP should be procyclical. Thus, real GDP is both procyclical and significantly related to bank loan supply.

The next step to complete this analysis will be to determine a bank loan supply with real GDP as one of the covariates. This is fraught with difficulties for many reasons. First, while GDP has been shown to have a positive effect on loans, it is also has positive effects on other factors that affect aggregate loan supply, such as aggregate deposits. Second, the time series nature of estimating a loan supply function using historical data tends to suffer from serial autocorrelation. Finally, loan supply functions based on time series data often suffer from unit root problems, because the supply of loans in the economy is not stationary.

Haselmann (2006) estimates a loan supply function in his study of bank lending activity in transitional economies. His model utilizes elements such as loan demand, the difference between the interest rates at which banks can lend and borrow, and gross domestic product to estimate the supply of loans in growing economies. He is able to show positive relationships between each of these factors and aggregate loan supply, which will serve as a good starting point for developing the model used in this paper.

Additionally, Jane Bogoev (1973) takes a rather different approach to estimating aggregate loan supply. As previously stated, Bogoev constructs a loan supply function for Macedonian banks in her hunt for the existence of a bank loan supply channel. Her model includes similar covariates such as real GDP and the market interest rate (named

MPI) but also includes terms such as the previous period's loan supply and the period's consumer price index (to capture the rate of inflation). Additionally, in Bogoev's model, natural logarithms of both real loan supply and real GDP are employed. Thus, Bogoev's model indicates that the model used in this paper must take the natural logarithm of real GDP and real loan supply and include loan supply in the previous period.

Finally, Önder and Özyildirim (2014) examine the role that borrowers play in punishing risky banks and rewarding safer banks in the nation of Turkey. Among other models, Önder and Özyildirim construct a loan supply function similar to both Haselmann's and Bogoev's. Similar to Haselmann's model, they include the spread between the rates at which the banks could borrow and lend. Also as in Bogoev's study, they include an inflation term and bank loan supply from the previous period. Furthermore, they utilize the natural logarithm of both the bank loan supply variable (interestingly enough, they did not include a variable for Turkey's real GDP). Additionally, they also include the natural log of real deposits in Turkey and a dummy variable called crisis, which took on a value of one during an economic crisis in Turkey and zero otherwise. Thus, their model confirms the usefulness of including the previous period's loan supply and utilizing the natural logarithm of the loan supply terms.

Thus, the literature shows that to determine whether or not bank loan supply is procyclical, a bank loan supply function will need to be constructed that includes the a variable for real GDP. An empirical model should also include terms to control for factors such as the market interest rate at which banks can lend, the natural logarithm of the bank loan supply from the previous period, and a dummy variable to account for any and all economic crises facing the United States. In the next section, a model will be constructed and data will be summarized to explain how the cyclicality of bank loan supply was (or was not) affected by the passage of the Basel I capital regulations.

CHAPTER THREE

Empirical Model and Data

Initial Model

Based on the literature review, it is clear what a model of the bank loan supply function should encompass. Along with the logarithm of the real quantity of bank loans supplied as the dependent variable, it should include as explanatory variables the natural logarithm of real GDP, the log of the quantity of loans supplied in the previous period, and a measure of the market interest rate at which banks lend funds since the previously discussed literature seems to imply that these variables have a significant effect on real loan supply. The natural logarithms of real loans and real GDP so that the regression coefficients calculated later can be interpreted as proportional differences between these two variables. In addition, for purposes of the present study, additional explanatory variables should include a dummy variable to account for the presence of an economic crisis (as recessions will often lead to loan supply shocks) and a dummy variable to account for seasonal or monthly differences (depending on the frequency of the data used).

Data on real bank lending volumes can be found at the Federal Reserve Economic Data (FRED) site provided by the Federal Reserve Bank of St. Louis. The nominal quantity of loans at all commercial banks in the United States is available on a quarterly, seasonally adjusted basis from January 1973 to July 2017 in billions of dollars (Loans), as is data on the on seasonally adjusted, 2009 GDP deflator (GDP Def) over the same interval. Then, by dividing each quarter's nominal quantity of loans supplied by each quarter's GDP deflator (divided by 100), the quarterly, seasonally adjusted real quantity of bank loans supplied (RealLoans) in 2009 dollars can be determined. Real GDP data for the same interval is available directly from FRED. Finally, the natural logarithm of each quarter's real quantity of loans (LNRL) and real GDP (LNRGDP) is computed for the full January 1973-July 2017 span of the data. A proxy for the market loan rate is the prime loan rate, or the rate that banks charge to their best customers. Quarterly January 1973-July 2017 data on the quarterly bank prime loan rate (PrimeRate) is available from FRED.

Additionally, FRED data on economic recession intervals is employed to construct a dummy variable to capture the role economic fluctuations in affecting loan supply. This variable takes on a value of 1 during quarters in which the United States economy is experiencing an economic recession (such as the first quarter of 2009) and 0 otherwise (Downturn). Finally, to adjust for any seasonal effects, a set of seasonal dummy variables is constructed. Q2 takes on a value of 1 in the second quarter and zero otherwise; Q3 assumes a value of 1 in the third quarter and 0 otherwise; and Q4 takes on a value of 1 in the fourth quarter and 0 otherwise. These data are summarized in Table 3.2.

Using these data, an initial empirical model can be employed:

$$LNRL_i = \beta_0 + \beta_1 LNRGDP_i + \beta_2 PrimeRate_i + \beta_3 Downturn_i + \beta_4 Q2_i + \beta_5 Q3_i + \beta_6 Q4_i + \beta_7 LNRL_{i-1} \quad (1)$$

Table 3.1: Descriptive statistics for the data used in Equation (1)

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Loans	179	825.8	508.8	140.4	2,113
RealGDP	179	10,680	3,699	5,292	17,170
GDPDef	179	73.10	24.94	25.66	113.6
PrimeRate	179	7.736	3.566	3.250	20.32
Time	179	89	51.82	0	178
RealLoans	179	10.25	3.348	5.419	18.72
LNRL	179	2.275	0.325	1.690	2.929
Downturn	179	0.179	0.384	0	1
LNRGDP	179	9.212	0.367	8.574	9.751
Q2	179	0.251	0.435	0	1
Q3	179	0.251	0.435	0	1
Q4	179	0.246	0.432	0	1

Revising the Initial Model

As all of the data used in Equation (1) will be time series data, the potential for autocorrelation is very high for this data set. The Dickey-Fuller unit root test is used to test for the existence of unit roots in any variables that might be susceptible to them. The first test will be for the natural log of the real quantity of loan, LNRL, with results showing a MacKinnon approximate p-value for the test statistic of 0.9916. As Dickey-Fuller uses a null-hypothesis of the existence of a unit-root, LNRL does appear to possess a unit root. One way to address is problem is to add the variable Trend, where trend equals the count of the current observation in order to capture the natural growth trend of LNRL. Regressing equation one with the Trend variable added results in stationary residuals (p-value of 0.0000), effectively addressing the autocorrelation problem.

The next variable to test is the natural log of real GDP, LNRGDP. The Dickey-Fuller test now shows a MacKinnon approximate p-value for the test statistic of 0.5771.

Thus, the possibility of a unit root cannot be dismissed. To remedy this, I will subtract from each quarter's natural log of real GDP the natural log of real GDP four quarters (one year) prior to create the new variable LagLNRGDP. Using the Dickey-Fuller test on laglnrgdp results in a MacKinnon approximate p-value for the test statistic of 0.0111, which provides a measure of assurance that the LagLNRGDP does not pose a unit-root problem.

The other six variables from Equation 1 can be assumed to involve unit-root issues. The presence of a unit root requires that variable in question be non-stationary, so its mean and variance would have to increase without bound as time passes, such as the natural log of a rapidly increasing variable like GDP. The dummy variables crisis, Q2, Q3, and Q4, however, obviously cannot be non-stationary, as their mean and variance are limited by the fact that their values are bound by 1 and 0. Additionally, while interest rates such as the prime rate could display unit root behavior, that would require them to rapidly increase or decrease with time, a trend that is not consistent across any large part of the interval, as seen in Figure 3.1. Thus, the PrimeRate variable should not suffer from the existence of a unit root.

Thus, a new equation can be constructed that now controls for the inherent autocorrelation caused by the rapidly increasing natural log of real GDP, with the updated data summarized in Table 3.2:

$$LNRL_i = \beta_0 + \beta_1 LagLNRGDP_i + \beta_2 PrimeRate_i + \beta_3 Downturn_i + \beta_4 Q2_i + \beta_5 Q3_i + \beta_6 Q4_i + \beta_7 LNRL_{i-1} + \beta_8 Trend \quad (2)$$

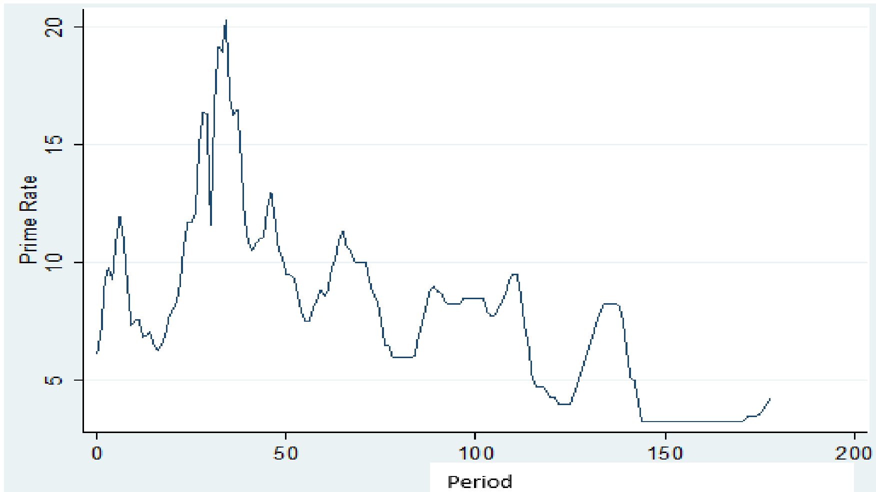

Figure 3.1. Quarterly Bank Prime Loan Rate from January 1973 to July 2017.

Table 3.2. Descriptive Statistics for the data used in Equation (2).

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Loans	179	825.8	508.8	140.4	2,113
RealGDP	179	10,680	3,699	5,292	17,170
GDPDef	179	73.10	24.94	25.66	113.6
PrimeRate	179	7.736	3.566	3.250	20.32
Time	179	89	51.82	0	178
RealLoans	179	10.25	3.348	5.419	18.72
LNRL	179	2.275	0.325	1.690	2.929
Downturn	179	0.179	0.384	0	1
LNRGDP	179	9.212	0.367	8.574	9.751
Q2	179	0.251	0.435	0	1
Q3	179	0.251	0.435	0	1
Q4	179	0.246	0.432	0	1
LagLNRGDP	175	0.0261	0.0214	-0.0415	0.0820
Trend	179	90	51.6720	1	179

Given that problems of autocorrelation taken into account, Equation (2) can now be tested for other common problems. The possibility of heteroscedasticity can be addressed through the use of robust standard errors. Next, the possibility of multicollinearity between the explanatory variables can be tested for using the Variance

Inflation Factor (VIF) test. Any variable with a VIF less than 10 is assumed to not suffer from multicollinearity with any other explanatory variable. None of these variables seem to suffer from multicollinearity. While Trend and LagLNRL seem to be slightly multilinear, all models have multicollinearity: it is only a matter of extent. Slight multicollinearity is a decent tradeoff for fixing the autocorrelation problems of LNRL. The results of this test are shown in Table 3.3.

Table 3.3: Variance Inflation Factors for the covariates in Equation (2).

VARIABLES	(1) VIF	(2) 1/VIF
Trend	12.97	0.077101
LagLNRL	10.37	0.096475
PrimeRate	2.51	0.398497
Downturn	1.69	0.592092
Q2	1.50	0.667801
Q3	1.51	0.663366
Q4	1.50	0.667801
LagLNRGDP	1.44	0.692446
Mean VIF	4.18	0.239234

Equation (2) appears to be relatively immune from the problems of autocorrelation, heteroscedasticity, and multicollinearity. Thus, (2) can now be used to test whether or not the Basel I capital regulations significantly affected the relationship between real loan supply and real GDP, and thus the cyclicality of bank loan supply.

CHAPTER FOUR

Experiment and Results

Running the Model

The empirical results are displayed in Table 4.1. As expected, the change in the natural logarithm of real GDP from the previous year has a positive, significant effect on LNRL, showing the natural procyclicality of real loan supply. Additionally as expected, the natural logarithm of the previous year's real loan supply and the bank prime loan rate also had a positive, significant effect on the natural logarithm of real loan supply, and all of their coefficients were positive: as predicted. Also interesting was the fact that the Downturn dummy variable had no significant impact on real bank loan supply. None of the seasonal dummy variables had a significant effect on real loan supply.

Table 4.1: Regression results from Equation (2)

LNRL	(1) Coef.	(2) Robust Std. Err.	(3) t	(4) $P>\|t\|$	(5) 95% Conf. Interval
LagLNRGDP	.38956	.08821	4.42	.000	[.21540, .56372]
PrimeRate	.00324	.00070	4.64	.000	[.00186, .00462]
Downturn	.00794	.00561	1.42	.159	[-.00314, .01903]
Q2	.00112	.00404	.28	.781	[-.00684, .00909]
Q3	.00087	.00380	.23	.819	[-.00663, .00838]
Q4	.00082	.00398	.21	.838	[-.00704, .00868]
LagLNRL	.97060	.01232	78.80	.000	[.94628, .99492]
Trend	.00041	.00009	4.36	.000	[.00022, .00059]
_cons	-.00116	.02022	-.06	.954	[-.04109,.03876]

Note: 175 observations were included, and resulting in an R-squared of 0.9969.

While these results are certainly enlightening, they give little information about whether and how the procyclicality of real loan supply, or the relationship between real loan supply and the GDP variable, changes over time. This will require a more detailed examination of the relationship between the variables LNRL (the natural logarithm of real loan supply) and LagLNRGDP (the difference between the natural logarithm of real GDP and the natural logarithm of real GDP a year prior). Figure 4.1 plots the values of LNRL through time for each period from January 1973 to July 2017. The vertical line drawn on period 80 (January 1993) represents the date that the Basel I Capital regulations were fully implemented in the United States, and the sloped line represents the trend in the values of LNRL.

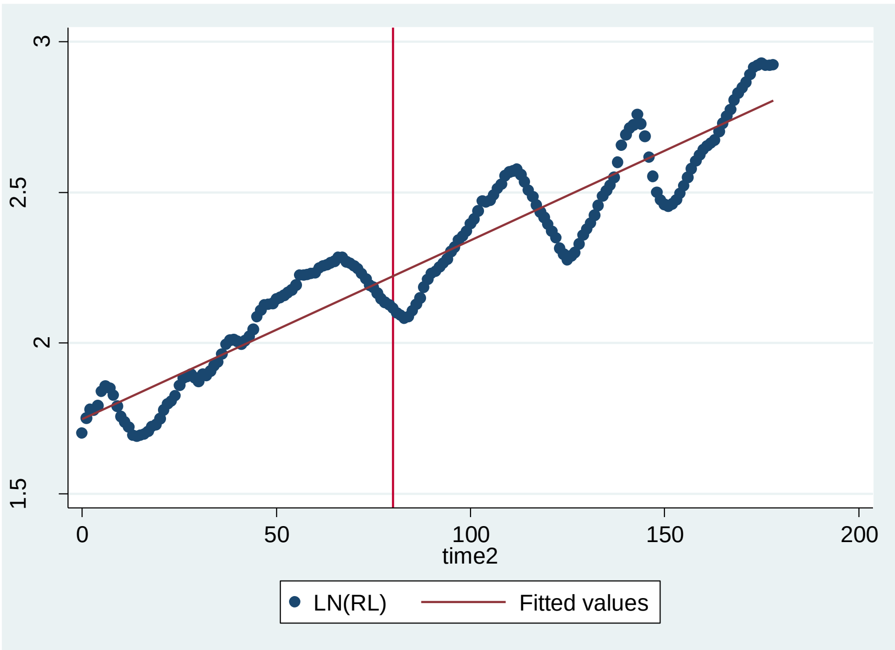

Figure 4.1. Natural Logarithm of Real Loan Supply through time, with the vertical line representing the date of Basel I implementation in the United States.

At first glance, it appears a change in the path of the natural logarithm of real loan supply occurs when the Basel I capital regulations are implemented. The values for

LNRL appear to increase more rapidly immediately after the implementation date. However, the growth experienced by LNRL before the implementation date becomes far less smooth after that date, as LNRL begins experiencing waves of growth followed by waves of contractions—a rather cyclical pattern. To increase the clarity of Figure 6, Figure 7 again shows the values of LNRL through time with a vertical line at the date of Basel I implementation. However, instead of one trend line for the values of LNRL over the entire interval, Figure 4.2 has two trend lines: one for the pre-Basel I period (red) and one for the Post Basel I period (green).

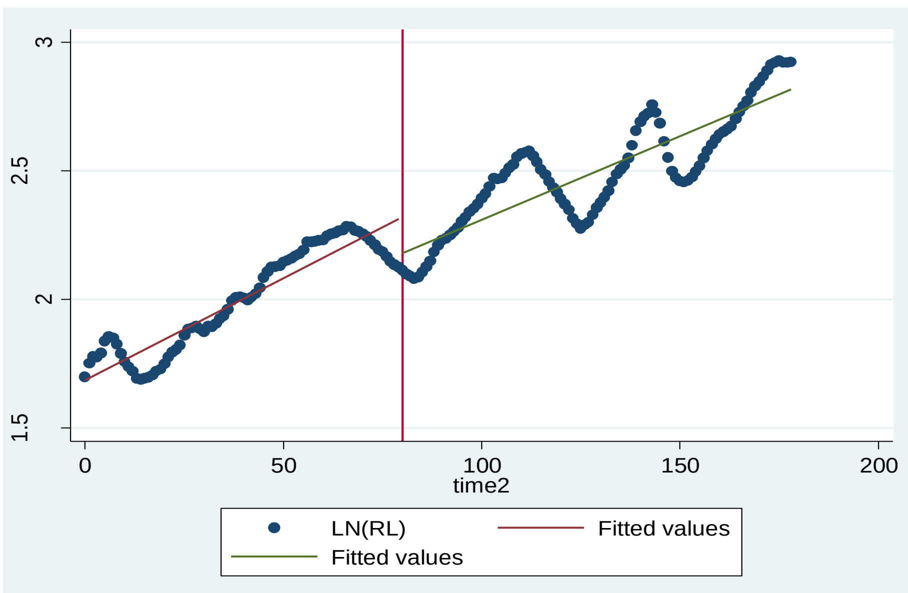

Figure 4.2. Natural Logarithm of Real Loan Supply through time, with the vertical line showing the Basel I implementation date and trend lines for both of the pre and post-Basel I periods.

As Figure 4.2 shows, there is certainly a change in the trend of lnrl at the date of Basel I implementation, due to the striking difference in the slope of the two trend lines. Based solely on examinaiton of Figure 7, however, it is not possible to determine whether or not this change is significant or simply due to random variation**.** To reach a determination regarding this issue, a Chow Test will be employed to determine whether or not the regression coefficient for LagLNRGDP in Equation (2) changes significantly at the Basel I implemenation date.

Conducting the Chow Test

To utilize the Chow Test, two new varaibles will be created. The first will be a dummy variable preBasel, which takes on a value of 1 for all periods before the Basel I implenetation date and 0 otherwise. The second will be a dummy varaible postBasel, which takes on a value of 1 for all periods at or following the date of Basel I implementation and 0 otherwise. Equation (2) will then be analyzed two more times, once for all periods for which preBasel equals one (before Basel I implementation) and once for all periods for which postBasel equals one (after Basel I implemenation). The results for the pre-Basel I regression are shown in Table 4.2 and the results for the post-Basel I regression are shown in Table 4.3.

To make for an easier comparison, Table 4.4 shows the regression coefficients and standard errors for regression equation (2), for (2) pre-Basel I, and for (2) post-Basel I.

Table 4.2: Regression results from Equation (2) for all periods before Basel I implemenation

LNRL	(1) Coef.	(2) Robust Std. Err.	(3) t	(4) P> $\|t\|$	(5) 95% Conf. Interval
LagLNRGDP	.29452	.08031	3.67	.000	[.13422, .45481]
PrimeRate	.00213	.00068	3.10	.003	[.00076, .00349]
Downturn	.00324	.00516	.63	.532	[-.00705, .01353]
Q2	.00277	.00595	.47	.643	[-.00910, .01464]
Q3	.00229	.00466	.49	.625	[-.00702, .00160]
Q4	.00102	.00423	.24	.809	[-.00741, .00946]
LagLNRL	1.02296	.02112	48.43	.000	[.98080, 1.06512]
Trend	-.00029	.00021	-1.39	.169	[-.00071, .00013]
_cons	-.06184	.03183	-.1.94	.056	[-.12537, .00169]

Note: 76 observations were included, and resulting in an R-squared of 0.9949.

Table 4.3: Regression results from Equation (2) for all periods after Basel I implemenation.

LNRL	(1) Coef.	(2) Robust Std. Err.	(3) t	(4) P> $\|t\|$	(5) 95% Conf. Interval
LagLNRGDP	.56511	.18297	3.09	.003	[.20161, .92861]
PrimeRate	.00969	.00126	7.66	.000	[.00718, .01220]
Downturn	.02191	.00889	2.46	.016	[.00425, .03957]
Q2	-.00028	.00461	-.06	.951	[-.00945, .00888]
Q3	-.00074	.00454	-.16	.871	[-.00975, .00828]
Q4	.00125	.00537	.23	.817	[-.00942, .01191]
LagLNRL	.92673	.01381	67.10	.000	[.89929, .95416]
Trend	.00121	.00012	9.73	.000	[.00097, .00146]
_cons	-.03846	.02530	-1.52	.132	[-.08872, .01179]

Note: 99 observations were included, and resulting in an R-squared of 0.9947.

Table 4.4: Regression coefficients for equations (2), (2) pre-Basel, and (2) post-Basel, as well as their standard errors

VARIABLES	(1) Full Model	(2) Pre Basel	(3) Post Basel
LagLNRGDP	0.38956***	0.29452***	0.56511***
	(0.08821)	(0.08031)	(0.18297)
PrimeRate	0.00324***	0.00213***	0.00969**
	(0.00070)	(0.00068)	(0.00126)
Downturn	0.00794	0.00324	0.021918***
	(0.00561)	(0.00516)	(0.00889)
Q2	0.00112	0.00277	-0.00028
	(0.00404)	(0.00595)	(0.00461)
Q3	0.00087	0.00229	-0.00074
	(0.00380)	(0.00466)	(0.00454)
Q4	0.00082	0.00102	0.00125
	(0.0398)	(0.00423)	(0.00537)
L.LNRL	0.97060 ***	0.1.02296***	0.92673***
	(0.01232)	(0.02112)	(0.01381)
Trend	0.00041***	-0.00029	0.00121***
	(0.00009)	(0.00021)	(0.00012)
Constant	-0.00116	-0.06184	-0.03846
	(0.02022)	(0.03183)	(0.02530)
Observations	175	76	99
R-squared	0.997	0.995	0.992

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

.

Table 4.4 makes very clear the behavior of the regression coefficient for LagLNRGDP around the date of the implementation of the Basel I capital requirements. In all three models, the regression coefficient is both positive and significant, as predicted. However, the regression coefficient for LagLNRGDP after Basel I implementation (0.56511) is much higher than the regression coefficient for LagLNRGDP before Basel I implementation (0.29452), with the regression coefficient for the full model lying in between (0.38956). This seems to suggest that the Basel I capital regulations led to an increase in the regression coefficient at the date of implementation, reinforcing the conclusions drawn from Figure 7 that Basel I made bank loan supply more procyclical.

However, to test whether or not the change in regression coefficient for LagLNRGDP was significant, the Chow Test must be taken to its conclusion. To do this, three more variables will be created. The first variable, d, will be a dummy variable that takes on a value of 1 for all periods at or prior to Basel I implementation and 0 otherwise (like postBasel). This dummy variable will represent the change in the intercept of Equation 2 due to the implementation of Basel I. The second variable will be named Chow_d, and it will be equal to the product of the variables LagLNRGDP and d. This variable will represent the change in the regression coefficient for LagLNRGDP due to the implementation of Basel I. The third variable, Chow_Trend, will equal the product of Trend and d to capture the change in the growth trend of LNRL after Basel I. These three variables will now be added to Equation 2.

$$LNRL_i = \beta_0 + \beta_1 LagLNRGDP_i + \beta_2 PrimeRate_i + \beta_3 Downturn_i + \beta_4 Q2_i + \beta_5 Q3_i + \beta_6 Q4_i + \beta_7 LNRL_{i-1} + \beta_8 Trend + \beta_9 d_i + \beta_{10} Chow_{d_i} + \beta_{11} Chow_{Trend} \qquad (3)$$

The results from analysis of (3) (over the entre data set) are shown in Table 4.5. Note that most of the regression coefficients do not change drastically (though most decreased slightly) and that the coefficient for LagLNRGDP is still positive and significant. These results indicate that the real loan supply is, as predicted, still procyclical even without the effects of Basel I. Both of the new variables, Chow_d and Chow_Trend were positive, which hints that Basel I may have increased the relationship between LNRL and LagLNRGDP (due to the positive coefficient for Chow_d) but decreased the overall supply of loans in the market (due to the negative coefficient for d). However, neither the coefficient for Chow_d nor the coefficient Chow_Trend is individually statistically significant.

The final step will be to test for the joint significance of the coefficients for both Chow_d and d to determine the procyclical effects of the Basel I Capital Regulations. Thus, an f-test will be conducted to test for the probabilities that the coefficients for both Chow_d and d equal zero. The results of this test are shown in Figure 4.3.

Table 4.5: Regression results from Equation (3)

LNRL	(1) Coef.	(2) Robust Std. Err.	(3) t	(4) P> $\|t\|$	(5) 95% Conf. Interval
LagLNRGDP	.34307	.07440	4.61	.000	[.19616, .48998]
Chow_Trend	.00044	.00010	4.42	.000	[.00024, .00063]
Chow_d	.31795	.19340	1.64	.102	[-.06395, .69985]
d	-.04053	.01197	-3.38	.001	[-.06418, -.01688]
PrimeRate	.00322	.00075	4.27	.000	[.00173, .00470]
Downturn	.00765	.00532	1.44	.153	[-.00286, .01817]
Q2	.00117	.00388	.30	.762	[-.00648, .00883]
Q3	.00093	.00364	.26	.798	[-.00625, .00811]
Q4	.00117	.00394	.30	.767	[-.00662, .00895]
LagLNRL	.98686	.01300	75.89	.000	[.96118, 1.01254]
Trend	.00004	.00014	.27	.785	[-.00023, .00031]
_cons	-.01661	.02082	-.80	.426	[-.05773, -.02451]

Note: 175 observations were included, and resulting in an R-squared of 0.9972.

As evident from Figure 4.3, the test statistic (6.62) is significant at the 5% confidence level. Thus, it is safe to conclude that the two regression coefficients are not jointly zero.

$$(1)\ Chow\_d = 0$$

$$(2)\ d = 0$$

$$F(2, 165) = 6.62$$

$$Probability > F = .0017$$

Figure 4.3. Dual F-test to test whether or not both Chow_d and d are both 0. The F-statistic of 6.62 is significant at the 5% level, allowing me to conclude that Chow_d and d cannot both be 0.

CHAPTER FIVE

Discussion

Based on the results of the Chow Test, both of the variables d and Chow_d are not jointly zero, meaning that a statistically significant increase in the regression coefficient for LagLNRGDP in equation (2) occurred after January 1993. Thus, the relationship between the natural logarithm of real loan supply and LagLNRGDP became significantly more positive after the implementation date of the Basel I capital regulations. As bank loan supply became more closely tied to fluctuations in real GDP, which is known to be highly procyclical, it can be concluded that bank loan supply became more procyclical after the implementation of the Basel I capital regulations. Thus, the Basel I capital regulations led to a more procyclical bank loan supply, confirming the visual results given in Figure 7.

This is quite interesting because it begins to call into question the usefulness of the Basel I capital regulations specifically and capital regulation in general. As bank loan supply is now more closely tied to the GDP of the United States (and thus the business cycle), changes in GDP will produce larger changes in bank loan supply than they would have before the Basel I capital regulations. Thus, during an economic expansion, real loan supply will expand even faster than it would have prior to the Basel I implementation, which would tend to enhance the expansion. However, during economic recessions, real loan supply will decrease even more sharply than it would have before the Basel I implementation, which would tend to worsen the recession. Thus, the increased procyclicality of bank loan supply that was caused by the Basel I capital regulations will lead to greater fluctuations in loan supply and related variables (such as investment) and thereby tend to destabilize the economy as a whole.

To strengthen this point, I will return the graph from Figure 4.1, which showed the growth of the natural logarithm of real bank loan supply over time. As evidenced in the graph, the natural logarithm of real loan supply experienced supernormal growth across many of the initial periods and then experienced relatively constant growth over the rest of the data set. Figure 13 shows the same growth of the natural logarithm of real loan supply with the high-growth beginning periods removed (starts April 1st, 1984).

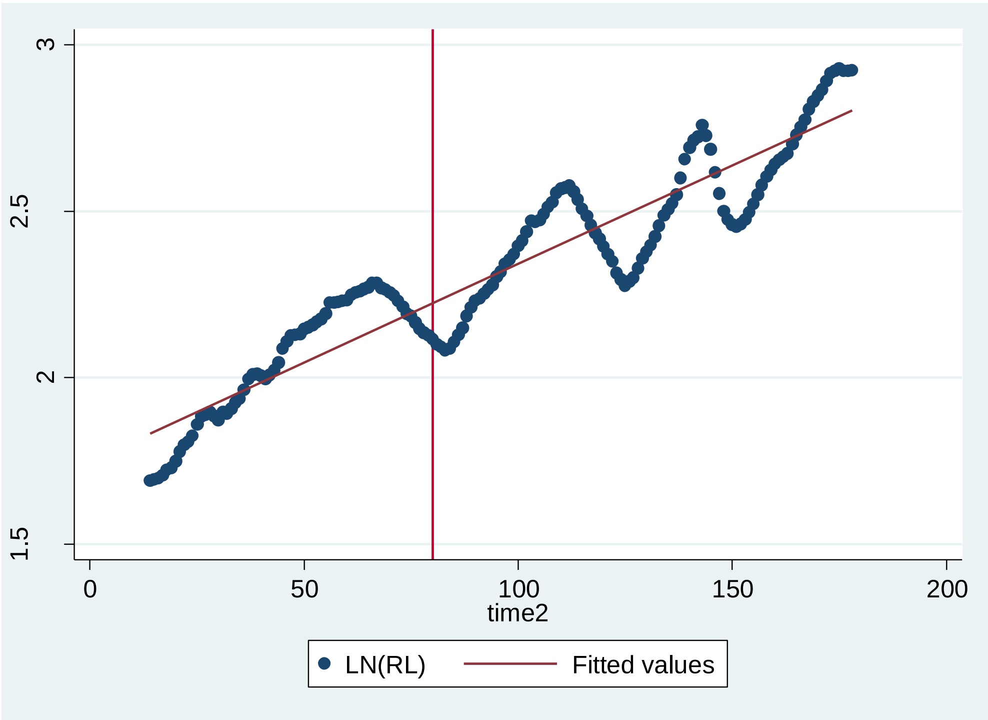

Figure 5.1. Natural logarithm of real loan supply over time, starting April 1st, 1984, with the vertical red line showing the data of Basel I implementation

Similar to Figure 4.1, Figure 5.1 clearly shows that the natural logarithm of real loan supply observed smooth growth prior to the implementation of the Basel I capital regulations (albeit with an interesting period of stagnation immediately preceding the implementation). After Basel I implementation, this quantity began to experience alternating periods of growth and decline—that is, a far more cyclical pattern. To examine the matter more deeply, Figure 5.2 graphs the natural logarithm of real loan supply over the same interval as in Figure 5.1, but now, like in Figure 4.2, it displays two different trend lines for the pre and post-Basel I periods.

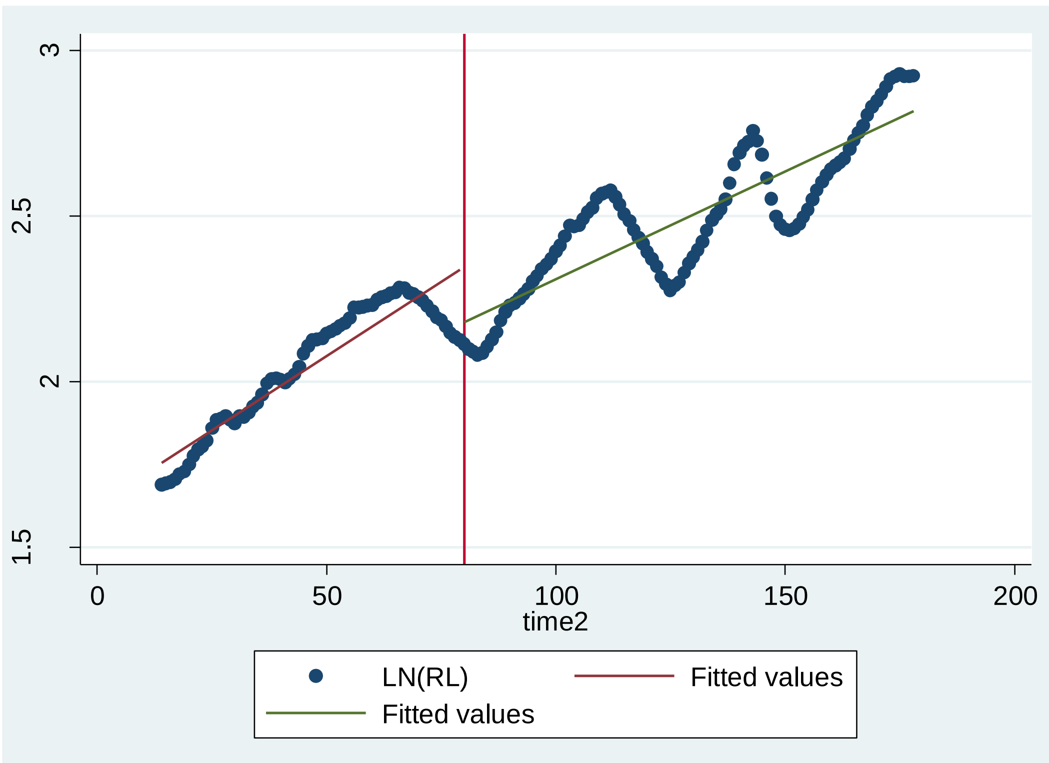

Figure 5.2: Natural logarithm of real loans supply over time, starting April 1st, 1984, with both a pre-Basel I (red) and post-Basel I (green) trend line

While the slopes of the two trend lines were drastically different in Figure 4.2, the two trend lines in Figure 5.2 appear to have very similar slopes. Thus, it appears that the natural logarithm of real loan supply experienced relatively similar growth before and after the implementation of Basel I. However, the period before Basel I experienced a relatively smooth, constant expansion of the natural logarithm of real loan supply, while the period following Basel I exhibited cyclical increases and decreases of real loan supply. It appears that the Basel I capital regulations had a very minor effect (if they had one at all) on the growth of real loan supply despite certainly leading to increased procyclicality. Qualitative arguments can be offered about the benefits of capital regulations (such as increased security for depositors), and an overall cost-benefit analysis of the Basel I capital regulations is beyond the scope of this paper. Nevertheless, it would seem that Basel I had a clear negative effect on real loan supply (increase procyclicality) while having no tangible benefits (such as increased growth of real loan supply).

Returning to Table 4.1, I wish to pay closer attention to the values of the regression coefficient for LagLNRGDP in Equation (2). The value of this coefficient is highest for the post-Basel I period and lowest for the pre-Basel I period, with the coefficient for the entire dataset taking on a value between these two extremes. This is consistent with the conclusion that the Basel I capital regulations increased the procyclicality of the real loan supply, as the relationship between the natural logarithm of the real loan supply and LagLNRGDP was strongest in the post-Basel period and weakest in the pre-Basel period. However, it is also very interesting to note that the standard deviation for the regression coefficient in the post-Basel I period (0.18297) was considerably higher than the standard deviation for the same coefficient in the pre-Basel I period (0.08031). Perhaps this is merely due to the fluctuations in the value of the natural logarithm of real loan supply over this interval due to its increasing cyclical behavior, but at the time I have no other explanation. Further studies may be conducted to determine why the relationship between the natural logarithm of real loan supply and LagLNRGDP became more variable following the Basel I implementation date and what effect (if any) this increased variability could have on similar experiments.

I would like to return to the stagnant period that the natural logarithm of real loan supply experienced immediately preceding the Basel I implementation date that can be observed in Figures 4.1, 4.2, 5.1, and 5.2. While the natural logarithm of real loan supply displayed relatively constant growth before the implementation date and cyclical growth following the implementation date, real loan supply experienced almost no growth in the period immediately preceding the implementation date (roughly from January 1990 to January 1994). This is of interest because at no other point in the interval does the natural logarithm of real loan supply stagnate, and it almost makes it seem like the Basel I capital regulations restarted the growth of the loan supply since growth resumed shortly after the implementation date. Perhaps banks halted their loan expansions because they were unsure how the new capital regulations would affect the industry. Regardless, this period could have also slightly affected the data as a whole, due to the sharp contrast it creates between the stagnation immediately preceding Basel I implementation and the rapid growth immediately prior to Basel I implementation.

The only explanation that immediately comes to mind is that Basel I was implemented over time and at different rates across the nations adopting the regulations. While January 1st, 1993 was the date that the Bank of International Settlements gives for the full implementation of Basel I in the United States (which is why it was used for the implementation date in this paper), certainly Basel I requirements began taking effect prior to 1993, and most (if not all) major banks would have been aware of the Basel I capital regulations even earlier. It is entirely possible that banks went through a period where they were preparing their balance sheets to meet the upcoming Basel I requirements, causing real loan supply to experience stagnation immediately before Basel I was implemented and then causing real loan supply to experience growth immediately after Basel I was implemented as banks were now meeting the new requirements. However, this is simply speculation and could be a topic of further study.

Finally, it would be very interesting to see additionally studies to show whether or not this procyclicality problem can be addressed. While it has been show by the literature that the Basel II capital regulations would lead to a more procyclical bank loan supply and by this paper than the Basel I capital regulations led to a more procyclical bank loan supply, it has also been pointed out that there are certainly some benefits than capital regulation theoretically offer, such as increasing bank capital positions to increase the chance that depositors will be able to withdraw their funds if the banks' fortunes sour. Whether or not these benefits outweigh the dangers of a more procyclical loan supply is yet to be determined. However, there is also the potential that a different regulatory or incentive-based framework could still obtain the benefits posed by the proponents of bank capital regulations while at the same time reducing the procyclical effects of capital regulation or even eliminating them entirely. While this again beyond the scope of this paper, it still poses an interesting avenue for further study

CHAPTER SIX

Conclusion

Throughout history, the banking history has sought to find solutions to the problems posed by a fractional reserve banking system. Because banks will have only a small fraction of their total deposits on hand as reserves at any given time, all of their depositors run the risk of losing a majority (if not all) of their funds if enough of the depositors came in to withdraw their funds at the same time (i.e. during a bank run before an economic recession). Many systems have been put in place to address this issue, such as state-run banks, deposit insurance, and (more recently) capital regulation like the Basel I requirements.

While capital regulation appears to be a very beneficial system in theory, many critics claim that the requirements these regulations place on bank balance sheets cause bank loan supply to behave in a more procyclical way. While bank loan supply is naturally procyclical, increased procyclicality could generate additional problems since loan supply will now contract even further during economic downturns, reducing the amount of loans available to businesses and consumers during recessions and thus retarding economic recovery: when they need loans the most. However, while the risk-based capital regulation framework of Basel II was clearly shown by the literature to have procyclical effects on bank loan supply, there was no such consensus on whether or not the non-risk-based capital regulation framework of Basel I would have similar procyclical effects. Thus, it was the goal of this paper to determine whether or not the Basel I capital regulations increased the natural procyclicality of bank loan supply.

Based on the relevant literature, it was determined that procyclicality of bank loan supply could be measured by constructing a loan supply function and then examining the relationship (as measured by the regression coefficient) between the real loan supply and real GDP. After constructing a new loan supply function based off of the examples used in the literature, I was able to conduct a Chow Test to determine whether or not the regression coefficient between the natural logarithm or real loan supply and LagLNRGDP increased significantly after the implementation date of the Basel I capital regulations (given by the BIS as January 1993).

Running the test showed that the regression coefficient in equation did increase by an economically small but statistically significant amount after the Basel I implementation date. This means that the real loan supply and real GDP were more closely tied after this date and thus, since real GDP is closely tied to the fluctuations of the business cycle, real loan supply was more closely tied to the business cycle. This shows that the implementation of the Basel I capital regulations led to a more procyclical bank loan supply, resulting in greater fluctuations in the real loan supply, including lower loan supply during economic recessions. Further studies may still be conducted to determine whether or not the proposed benefits of such capital regulations outweigh their costs (such as procyclicality) or whether or not a similar system can be put in place to maintain the benefits offered by capital regulations while reducing their inherent procyclical side effects.

BIBLIOGRAPHY

Ayuso, Juan, Daniel Pérez, and Jesús Saurina. "Are Capital Buffers Pro-Cyclical?: Evidence from Spanish Panel Data." *Journal of Financial Intermediation*, Bank Capital Adequacy Regulation under the New Basel Accord, 13, no. 2 (April 1, 2004): 249–64. https://doi.org/10.1016/S1042-9573(03)00044-5.

Board of Governors of the Federal Reserve System (US). "Bank Prime Loan Rate." FRED, Federal Reserve Bank of St. Louis, January 1, 1949. https://fred.stlouisfed.org/series/MPRIME.

———. "Commercial and Industrial Loans, All Commercial Banks." FRED, Federal Reserve Bank of St. Louis, January 1, 1947. https://fred.stlouisfed.org/series/BUSLOANS.

Bogoev, Jane. "Banks' Risk Preferences and Its Impact on the Loan Supply Function: An Empirical Investigation for the Republic of Macedonia." *Journal of Business and Economics (Air University)* 1, no. 2 (July 2009): 160–203.

Bordo, Michael D., John V. Duca, and Christoffer Koch. "Economic Policy Uncertainty and the Credit Channel: Aggregate and Bank Level U.S. Evidence over Several Decades." *Journal of Financial Stability* 26, no. Supplement C (October 1, 2016): 90–106. https://doi.org/10.1016/j.jfs.2016.07.002.

Brückner, Markus, and Mark Gradstein. "Government Spending Cyclicality: Evidence from Transitory and Persistent Shocks in Developing Countries." *Journal of Development Economics*, Special Issue: Imbalances in Economic Development, 111 (November 1, 2014): 107–16. https://doi.org/10.1016/j.jdeveco.2014.08.003.

Drumond, Ines. "Bank Capital Requirements, Business Cycle Fluctuations and the Basel Accords: A Synthesis." *Journal of Economic Surveys* 23, no. 5 (December 2009): 798–830. https://doi.org/10.1111/%28ISSN%291467-6419/issues.

Frait, Jan, and Zlatuse Komarkova. "Loan Loss Provisioning in Selected European Banking Sectors: Do Banks Really Behave in a Procyclical Way?" *Finance a Uver/Czech Journal of Economics and Finance* 63, no. 4 (2013): 308–26.

Goodhart, Charles, Boris Hofmann, and Miguel Segoviano. "Bank Regulation and Macroeconomic Fluctuations." *Oxford Review of Economic Policy* 20, no. 4 (2004): 591–615.

"Gross Domestic Product: Implicit Price Deflator | FRED | St. Louis Fed." Accessed January 26, 2018. https://fred.stlouisfed.org/series/GDPDEF.

Hamilton, James. "Dates of U.S. Recessions as Inferred by GDP-Based Recession Indicator." FRED, Federal Reserve Bank of St. Louis, October 1, 1967. https://fred.stlouisfed.org/series/JHDUSRGDPBR.

Haselmann, Rainer. "Strategies of Foreign Banks in Transition Economies." *Emerging Markets Review*, Financial market development in the Central and Eastern European countries, 7, no. 4 (December 1, 2006): 283–99. https://doi.org/10.1016/j.ememar.2006.09.002.

Hofmann, Bernd. "Procyclicality: The Macroeconomic Impact of Risk-Based Capital Requirements." *Financial Markets and Portfolio Management* 19, no. 2 (August 2005): 179–200.

Ibrahim, Mansor H. "Business Cycle and Bank Lending Procyclicality in a Dual Banking System." *Economic Modelling* 55 (June 1, 2016): 127–34. https://doi.org/10.1016/j.econmod.2016.01.013.

"Implementation of Basel II: Practical Considerations," July 28, 2004. https://www.bis.org/publ/bcbs109.htm.

Liu, Guangling (Dave), and Nkhahle E. Seeiso. "Basel II Procyclicality: The Case of South Africa." *Economic Modelling* 29, no. 3 (May 1, 2012): 848–57. https://doi.org/10.1016/j.econmod.2011.10.015.

Lowenstein, Roger. *America's Bank: The Epic Struggle to Create the Federal Reserve*. New York: Penguin Press, 2015.

McCully, Clinton P. "Trends in Consumer Spending and Personal Saving, 1959-2009." *Survey of Current Business* 91, no. 6 (June 2011): 14–23.

Miller, Roger LeRoy, and David D. VanHoose. *Money, Banking, and Financial Markets*. 3rd ed. Mason, MN: Thomson South-Western West, 2007.

Onder, Zeynep, and Suheyla Ozyildirim. "Bank Quality, Loan Demand, and Market Discipline." *Emerging Markets Finance and Trade* 50, no. 4 (July 2014): 61–72.

"R090805d.Pdf." Accessed January 12, 2018. https://www.bis.org/review/r090805d.pdf.

Repullo, Rafael, and Javier Suarez. "The Procyclical Effects of Bank Capital Regulation." *Review of Financial Studies* 26, no. 2 (February 2013): 452–90.

Shinagawa, Shunsuke. "Endogenous Fluctuations with Procyclical R&D." *Economic Modelling* 30 (January 1, 2013): 274–80. https://doi.org/10.1016/j.econmod.2012.09.024.

Solon, Gary, Robert Barsky, and Jonathan A. Parker. "Measuring the Cyclicality of Real Wages: How Important Is Composition Bias?" *Quarterly Journal of Economics* 109, no. 1 (February 1994): 1–25.

Sumner, William Graham, ed. *A History of Banking in All the Leading Nations*. Library of Money and Banking History. New York: A. M. Kelley, 1971.

Timberlake, Richard H. *The Origins of Central Banking in the United States*. Cambridge, Mass: Harvard University Press, 1978.

U.S. Bureau of Economic Analysis. "Real Gross Domestic Product." FRED, Federal Reserve Bank of St. Louis, January 1, 1947. https://fred.stlouisfed.org/series/GDPC1.

VanHoose, David D. *The Industrial Organization of Banking: Bank Behavior, Market Structure, and Regulation*. Berlin ; London: Springer, 2010.