6-2015

Three Essays on Capital Regulations and Shadow Banking

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THREE ESSAYS ON CAPITAL REGULATIONS AND SHADOW BANKING

by

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A dissertation submitted to the Graduate College
in partial fulfillment of the requirements
for the degree of the Doctor of Philosophy
Economics
Western Michigan University
June 2015

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Western Michigan University, 2015

The shadow banking sector is a sector that is comprised of financial intermediaries that do not have access to central bank funds and performs their activities outside the regular banking system. This sector had been rapidly growing in most developed economies. This dissertation focuses on the behavioral difference and interaction of the traditional and shadow banking sectors as displayed by the relative asset position of both sectors, their risk-taking positions, and their business-cycles properties.

The first essay examines the impact of minimum capital requirements on the share of shadow to total banking assets. Previous literature has argued that increased regulation of the traditional banking sector will lead to regulatory arbitrage and an increase in shadow banking activities. That is, banks shift their operation away from traditional banking into the less regulated shadow banking sector when traditional banking activities are more heavily regulated. This hypothesis is tested using data from 76 countries over the 2005 through 2010 period. The results provide some evidence in favor of the regulatory arbitrage hypothesis, but only for high-income countries.

The second essay focuses on bank risk-taking behavior when the capital requirement is strengthened. Risk is proxied by the share of non-performing loans to total loans in the bank's portfolio. Using cross-section data from 82 countries, it examines whether one

banking sector takes on more risks than the other sector when a specific risk-based capital regulation is applied. The shadow banking sector is found to take on higher risks, as displayed by the loan failures, than the traditional banking sector in response to enhanced capital regulations.

The third essay uses the relationship between leverage and assets to quantify the pro-cyclicality of leverage and evaluates the impact of Basel II implementation on pro-cyclicality. Using panel data from 113 countries over the period of 2005-2012, pro-cyclicality is examined for the shadow and traditional banking sectors. The key results indicate that the traditional banking sector tends to be less pro-cyclical than the shadow banking sector and that Basel II implementation intensifies the pro-cyclicality.

ACKNOWLEDGMENTS

First of all I would like to express my special gratitude to my committee chair, Dr. Susan Pozo. Without her guidance, advice, and encouragement, completing this dissertation would not have been possible. I would like to thank Dr. Debasri Mukherjee for her constructive advice in methodologies and Dr. Isabel Ruiz Olaya for her valuable feedbacks to improve my dissertation.

Secondly, I wish to thank the professors and staff of the Economics Department who assisted me through the doctoral program and my classmates and friends that makes my journey more enjoyable. Studying/living in the U.S. is one of the most important experience in my life.

Last but not least, I would like to thank my mom, sister, and brother at home with their constant support and understanding during the duration of the doctoral program.

Diny Ghuzini

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CHAPTER 1
INTRODUCTION

The shadow banking sector is a sector that is comprised of financial intermediaries that do not have access to central bank funds and performs their activities outside the regular banking system. This sector has been rapidly growing in most developed economies. The emergence of the shadow banking sector has yielded both costs and benefits (Claessens et al. 2012, Poszar et al. 2012). On the benefit side, shadow banks reduce the cost of credit and provide a broader array of investment options and banking services. The shadow banking sector provides substantial benefits to borrowers and to the wider economy by increasing efficiency and by providing liquidity and funding. On the costs side, the shadow banking sector is a source of systemic risk, which has a negative impact on economic activity.

The Institute for International Finance (IIF, 2012) lists four benefits of the shadow banking sector. It provides efficient financial services. As argued by Pozsar et al. (2010), a second benefit of the shadow banking sector is driven by specialization and comparative advantages over the traditional banking sector. The sector allows investors to reduce their risks by spreading and diversifying their assets into several financial instruments and enables them to borrow from various sources. A third benefit is that it offers flexibility and more investment opportunities in addition to services from the traditional sector. Finally, the sector provides more liquidity and funding for borrowers and other market participants.

Discussion of the shadow banking system highlights three possible costs; it contributing toward systemic risk, regulatory arbitrage may takes place, and its contribution toward pro-cyclicality of the financial sector (Financial Stability Board,

2011). Hence, the benefits of the shadow banking sector are accompanied by costs, i.e. the risk associated with the shadow banking activities. The risks contribute toward systemic risk when they are not managed effectively. For example, it has been argued that shadow banking played a significant role in the recent global financial crisis. The potential systemic risk is due to the interconnectedness of the shadow banking sector with the various sources of funding including households, corporates, and financial institutions and with its interactions with the traditional banking system. The shadow banking sector is characterized by less regulation than the traditional sector. Minimum capital requirements proposed by the Basel Accords are primarily directed toward the traditional banking sector, therefore there is a concern over the possibility of regulatory arbitrage. Bank will find a way to evade the regulations causing the regulations to induce the growth of shadow banking activities. This arbitrage itself may be used by banks to increase their leverage.

Shadow banking sector activities concentrate on maturity, credit, and liquidity transformation (Pozsar et al., 2010). Shadow banks use non-deposit instruments such as money market funds and commercial papers to raise funds and transform them into longer-term assets. These activities can facilitate banks to achieve higher leverage. The higher leverage may amplify the pro-cyclicality of banking activity, i.e. leverage is high during booms and low during busts.

This dissertation examine the effect of banking regulation, specifically the minimum capital requirements and Basel II recommended by the Basel Committee on Banking Supervision (BCBS). BCBS was established in response international financial market disruptions that followed the collapse of the Bretton Wood managed exchange rate system in 1973 as well as other financial disruptions. The breakdown of the system led to large

foreign currency losses incurred by banks in many countries. The committee was established at the end of 1974 by the central bank governance of G10 countries. Up to 2014 the membership of the committee has expanded and now consists of representatives of the central banks and banking supervisory authorities from 28 jurisdictions and 3 observer countries. The member countries and jurisdictions are Argentina, Australia, Belgium, Brazil, Canada, China, European Union, France, Germany, Hong Kong SAR, India, Indonesia, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, Russia, Saudi Arabia, Singapore, South Africa, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States. The country observers are Chile, Malaysia, and United Arab Emirates.

The goal of the committee is "to strengthen the regulation, supervision and practices of banks worldwide with the purpose of enhancing financial stability". The committee serves as a forum for cooperation of the members on banking supervision. It seeks to achieve the goal by: 1) exchanging information on developments in the banking sector and financial markets to help identify current or emerging risks for the global financial system; 2) sharing supervisory issues, approaches and techniques to promote common understanding and to improve cross-border cooperation; 3) establishing and promoting global standards for the regulation and supervision of banks as well as guidelines and sound practices; 4) addressing regulatory and supervisory gaps that pose risks to financial stability; 5) monitoring the implementation of BCBS standards in member countries and beyond with the purpose of ensuring their timely, consistent and effective implementation and contributing to a "level playing field" among internationally-active banks; 6) consulting with central banks and bank supervisory authorities which are not members of the BCBS to benefit from their input into the BCBS policy formulation process and to

promote the implementation of BCBS standards, guidelines and sound practices beyond BCBS member countries; and 7) coordinating and cooperating with other financial sector standard setters and international bodies, particularly those involved in promoting financial stability (Banks for International Settlements, 2013).

Capitalization of internationally active banks became the main focus of the committee in the 1980s. In the mid-1980s there was a large increase in cross-border banking activities (Petersen and Mukuddam-Petersen, 2014). Latin American debt crisis also took place during this period. At the same time international banks have suffered the deterioration of capital ratios. Another concern is that some international banks avoid regulations by relocating to jurisdictions or countries that have less strict regulations. Therefore, the issue of standardized capital is critical to maintaining global banking system stability. In 1988 the first Basel Accord (Basel I) was introduced in an attempt to set or harmonized bank capital regulation at the international level. This standards is designed to establish a more stable banking system and lessen the discrepancy in bank competitiveness across jurisdictions and across countries (Petersen and Mukuddam-Petersen, 2014).

The Basel Accords mostly deal with the effort to maintain a sufficient level of capital. To determine the sufficient level of capital, Basel I adopted a capital adequacy ratio (CAR), which is the ratio of bank capital and risk-weighted assets (RWA). Basel I sets the CAR to be at least 8% in order to be adequately capitalized. Under Basel I, capital is defined as Tier 1 and Tier 2 capital. Therefore, banks must maintain Tier 1 and Tier 2 capital to be at least 8% of its risk-weighted assets. Tier 1 capital is also referred to as core capital that has a strong capacity to absorb losses (Petersen and Mukuddam-Petersen, 2014). It consists of shareholders' equity and retained earnings (Gup, 2004). Tier 2 capital

is considered less reliable than Tier 1 capital. It includes additional internal and external funds available to the bank such as subordinated debt and asset loss reserves. Subordinated debts are bank-issued debts, for example bonds, that do not have to be repaid until all other debts have been settled (Petersen and Mukuddam-Petersen, 2014).

The Basel I capital standard focuses mainly on credit risks. It is a simple risk-based standard that uses only four risk weights for the following assets: 0% for cash and claims on Organization for Economic Cooperation and Development (OECD) sovereigns, 20% for claims on OECD banks, OECD subnational government entities, and cash items in process of collections, 50% for mortgage and local government projects finance in the OECD countries, and 100% for commercial and consumer loans and loans to non-OECD governments (Gup, 2004). The simple weight structure of Basel I prevented the capital requirement from adequately reflecting the associated risks. Banks tend to shift their portfolio's composition toward lower quality assets in order to maintain the regulatory capital ratio. In this situation, the regulatory capital ratio remains unchanged but the actual risks increase. The simple structure cannot accommodate various types of banks that have different risk profiles.

Basel II, which was introduced in 2001, is aimed to improve Basel I capital regulations. The main difference from Basel I is that Basel II accommodates for a more flexible risk weights. Basel II consists of three pillars: 1) minimum requirements, 2) supervisory review, and 3) market disciplines (Bank for International Settlements). The calculation of capital adequacy falls under the first pillar. Under Basel II, the definition of capital and CAR do not change. It retains the minimum capital (CAR) to be at least 8% of RWA. However, Basel II modifies the methodology for calculating RWA. The calculation

of RWA incorporates credit risk, market risk, and operational risk. Measures of credit risks are more complex in order to align the calculation of perceived risk of bank's assets to the actual risk. Credit risk can be measured using the Standardized Approach, the Foundation Internal Rating Based Approach, and the Advanced Internal Rating-Based Approach. The Standardized Approach is the simplest approach and more suitable for smaller banks while the other two approaches are more suited for larger banks. The Standardized Approach adds two more risk categories in addition to four categories used in Basel I. Moreover, it uses external credit ratings from credit rating agencies to determine certain exposures' risk weights (Banks for International Settlements).

Basel III mainly sets the standards for liquidity. Liquidity involves bank's ability to purchase assets and meet its financial obligations without experiencing damaging losses. Bank liquidity decreased during the 2007 financial crisis and has motivated the introduction of Basel III capital and liquidity regulation in 2010 (Petersen and Mukuddam-Petersen, 2014).

This dissertation focuses on the implementation of Basel II and the minimum capital requirements. Given the development and more significant role of the shadow banking system around the globe in the last several years, this dissertation examines asset positions, risk taking, and pro-cyclicality in relation to the implementation of Basel in the traditional and shadow banking sector.

The first essay examines the impact of minimum capital requirements on the shadow banking sector. The share of shadow to total banking assets is used to measure shadow banking growth. Previous literature has argued that increased regulation of the traditional banking sector will lead to regulatory arbitrage and increase in shadow banking

activities. That is, banks shift their operation away from traditional banking into the less regulated shadow banking sector when traditional banking activities are more heavily regulated. This hypothesis is tested using data from 76 countries over the 2005 through 2010 period. The results provide some evidence in favor of the regulatory arbitrage hypothesis, but only for high-income countries.

The second essay focuses on bank risk-taking behavior when the capital requirement is strengthened. Risk is proxied by the share of non-performing loans to total loans in the bank's portfolio as a measure of ex-post risk and bank z-score as a measure of ex-ante risk. The shadow banking sector is found to take on higher ex-ante risk while the traditional banking sector tend to take on higher ex-post risks. Capital requirement is found to be effective in reducing both ex-post and ex-ante risks

The third essay uses the relationship between leverage and assets to quantify the pro-cyclicality of leverage and evaluates the impact of Basel II implementation on leverage growth. Using panel data from 111 countries over the period of 2005-2011, pro-cyclicality is examined for the shadow and traditional banking sectors. The key results indicate that the traditional banking sector tends to be less pro-cyclical than the shadow banking sector and that Basel II implementation intensifies the pro-cyclicality.

The three essays show that the shadow banking and traditional banking sectors behave differently in term of their asset positions, risk taking, and pro-cyclicality. The results also suggest that bank and country heterogeneity play a role in the behavioral differences detected across sectors.

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CHAPTER 2

CAPITAL REGULATION AND SHADOW BANKING

2.1 Introduction

This essay examines the impact of national minimum capital requirements on the share of shadow banking assets to total banking assets across countries. The shadow banking sector comprises of financial intermediaries that do not have access to central bank funds and perform their activities outside the regular banking system (Financial Stability Board, 2011). Pozsar et al. (2013) and Acharya et al. (2013) have argued that capital requirement regulations lead to regulatory arbitrage. That is, banks shift their operations away from traditional banking into the less regulated shadow banking sector when traditional activities are more heavily regulated. Acharya et al. (2013) argued further that regulatory arbitrage is the main motivation for setting up conduits, one of the most common financial instruments used in shadow banking. If regulatory arbitrage holds, then we should expect to see that a more stringent capital requirement encourages a relatively larger shadow banking sector, all other thing equal. Pozsar et al. (2013) identify additional determinants of shadow banking activities in addition to regulatory capital arbitrage. Shadow banking activities may arise from financial intermediation outside traditional banking due to specialization and comparative advantage over the traditional banking system. However, in this study we will focus on the regulatory arbitrage explanation for shadow banking growth.

The shadow banking system has been growing quickly in most developed economies, at least until the global financial crisis. From 2004 to 2008, U.S. shadow

banking assets exceeded traditional banking assets, although falling since 2008 (Deloitte, 2012). Pozsar et al. (2013) document that the U.S shadow banking system size, measured by bank liabilities, was about $22 trillion in June 2007, which is significantly larger than traditional bank liabilities at about $14 trillion. After the financial crisis, the size of the shadow banking sector has fallen but the liabilities of traditional banking sector continue to grow. Acharya et al. (2010) show that asset-backed commercial paper conduits (ACBP) have the biggest share of money market instruments in 2007. The ACBP is one of the most representative financial instruments in the shadow banking system.

This essay distinguishes traditional from shadow banks according to the standard industrial classifications (SIC) from the Office of Occupational Safety and Health Administration (OSHA). Specifically, we classify financial institutions under SIC code 60 as traditional banks and SIC code 61 as shadow banks. Traditional banks, often referred to as depository institutions, are subject to regulatory capital. The capital requirement is designed to provide a safety net and limits banks from taking excessive risks. Capital requirements are aimed at mitigating risks in the traditional banking sector by ensuring that there is enough capital to sustain losses. However, if capital requirements encourage shadow banking growth through regulatory arbitrage then risks are simply transferred into the shadow banking sector. Thus, if the regulatory arbitrage hypothesis is in fact correct, capital requirements cannot effectively minimize banking risks when shadow banking activity is less regulated and not subject to capital requirements. Most countries apply capital requirements for banks as proposed by Basel I or Basel II. Basel I and II required banks to maintain a minimum 8% capital adequacy ratio. The capital adequacy ratio is

calculated as the ratio of the bank's capital to its risk-weighted assets (Petersen and Mukuddam-Petersen, 2014).

Following the financial crisis, the global trend in banking regulation is to heighten the capital requirements. Basel III sets yet a higher capital requirement compared to Basel I and II. The total capital requirement, set at 10.5%, will be implemented in 2019. Basel III also adds leverage ratio requirements to supplement the minimum capital requirements (Bank for International Settlements). Studies that investigate the role of banking regulation (Hanson et al. 2011 and Adrian and Ashcraft, 2012) suggest that while higher regulatory capital helps to reduce the impact of a shock, it also increases shadow banking activity.

This essay examines whether minimum capital requirements have an impact on shadow banking assets. The sample contains panel data from 76 countries over the period 2005, 2008, 2009 and 2010. Shadow banks are defined as Non-depository Credit Institutions (code 61) under the Standard Industrial Classification (SIC) system and shadow banking activity is measured by the share of shadow banking assets to the sum of shadow and traditional bank assets. The minimum capital requirement that is used in this study is collected from the Bank Regulation and Supervision Survey (BRSS) conducted by the World Bank.

The results suggest that capital requirements have an impact on the share of shadow banking assets to total banking assets only in high income countries. Therefore, it seems that the regulatory arbitrage hypothesis is supported in these countries. These results are in accordance with the previous studies (Pozsar et al. 2013 and Acharya et al. 2013) who simply use descriptive statistics or ACBP conduits suggesting that regulatory arbitrage takes place.

Furthermore, most of the previous studies examine the shadow banking sector in the developed countries only. To the best of our knowledge this is the first study to empirically test in a rigorous manner the regulatory arbitrage hypothesis using the relative size of traditional and shadow banking assets in both low and high income economies.

The rest of this chapter is organized as follows. In the next section I present the literature review. Section 3 explains capital regulation across countries. Section 4 describes the data that are used. Section 5 and 6 discuss the empirical model and results and finally section 7 concludes.

2.2 Literature Review

The literature on shadow banking is relatively recent. Most studies that investigate the role of shadow banking have been motivated by the recent global financial crisis. There is variation in how the literature defines shadow banking as well as how to measure it. The term shadow banking was coined by Paul McCulley (2007) who define it as "the whole soup of levered up non-bank investment conduits, vehicles, and structures". Pozsar et al. (2010) provide a broader definition, "shadow banks are financial intermediaries that conduct maturity, credit, and liquidity transformation without access to central bank liquidity or public sector credit guarantees". Schwarz (2012) argues that even the broader definition only covers entities. He further defines shadow banking activity to comprise not only the products and services provided by shadow bank but also the financial markets that facilitate the provision of those products and services.

Studies have been using different proxies to measure shadow banking. Pozsar et al. (2012) measure the shadow banking size using data from the Federal Reserve Board's flow

of funds. The data consist of liabilities related to securitization activity and short term money market transactions that are not backstopped by deposit insurance. Summing these can provide a measure of the size of the shadow banking sector. Adrian and Shin (2009) define the shadow banking system as market-based financial system especially those that are involve in securitization process. Some examples of institutions that are involve in the securitization process are government sponsor enterprises, asset-backed securities (ABS) issuers, and broker-dealers. Acharya et al. (2013) uses asset-backed commercial paper (ABCP) conduits to identify shadow banking activity. Other studies such as Acharya et al. (2010) define shadow banks based on the standard industrial classifications (SIC) codes, defining shadow banks as financial institutions categorized under the two-digit SIC code 61.

Following the global financial crisis, there is a trend of imposing heighted capital requirement regulation on the traditional banking system. Basel III, which will be fully phased in by 2019 increases the minimum capital requirement to 10.5%. The financial crisis also motivated literature that emphasizes and proposes regulatory reform to maintain shadow banking system stability (Adrian and Shin, 2009 and Adrian and Ashcraft, 2010). Since the adoption of the first Basel accord, capital requirement regulations have been an important feature of the banking industry.

Capital requirement regulations have been argued to cause regulatory arbitrage. The first working paper (Jackson et al. 1999) by the Basel committee assesses the impact of capital requirements empirically after ten years of implementation of the first Basel accord. This study examines whether the capital requirements are effectively limiting risk taking behavior since capital requirements are intended to limit banks from taking excessive risk.

The study also examines, whether instead of restricting the risk taking, capital requirements induce banks to behave in ways that reduce the effectiveness of the requirements. One way to do this is through capital regulation arbitrage. Jackson et al. (1999) argue that capital regulation arbitrage is a result of keeping the funding cost low. As cost of equity is perceived to be higher than cost of debt (Stein, 2012), minimum capital requirement is seen as a form of taxation by banks. Capital regulation arbitrage is used as a devise to avoid or minimize the taxes.

Jackson et al. (1999) identify several methods of capital regulation arbitrage in the U.S. as the reaction from the first Basel accord. For instance bank may shift the portfolio composition towards the riskiest assets within a particular risk-weight category so that the capital ratio is unchanged while the overall risk increases. Kashyap et al. (2010), Pozsar et al. (2013) and Acharya et al. (2013) suggest that capital regulation arbitrage encourages migration of credit creation activity from traditional to shadow banking. That is, higher capital requirements increases shadow banking size.

Studies that formally analyze capital regulation arbitrage are limited. Plantin (2014) formulates optimal capital requirement regulations when there exist endogenous financial innovation. If the enforcement of such regulation is not perfect, banks can get around the capital requirement regulation and shift towards shadow banking system to increase leverage. The more constrained is a bank by the capital requirement the more it is willing to shift its activity. Therefore increasing capital requirements boost the relative size of the shadow banking sector.

2.3 Capital Regulatory Framework

2.3.1 Basel's Minimum Capital Requirements

In most countries banks are subject to minimum capital requirements. Traditional requirements require banks to hold a certain amount of capital. Other countries require a specific leverage capital ratio, that is, the ratio of capital to assets. This ratio is intended to keep capital in line with the balance sheet size. Recognizing that the creditworthiness of borrowers vary, risk-based capital ratio requirements were introduced by the 1988 Capital Accord (Basel I). The accord was proposed by the Basel Committee on Banking Supervision (BCBS). It requires a risk-based capital ratio of at least 8% for credit risk. Risk-based capital ratio assigns different risk weights according to the borrower's ability to meet its obligation (Lind, 2005).

The Basel II framework was initially introduced in 2004. It was proposed to incorporate the developments, in theory and in practice, of measuring risk. It has three pillars, minimum capital requirements, supervisory review, and market discipline (Bank for International Settlements). Figure 1 displays these three pillars. Pillar 1 contains the capital requirements for credit risk, market risk and operational risk. Under Pillar 1, banks may choose from different alternatives to calculate the capital ratio. The choice of approach usually depends on the banks' level of complexity. There are at least two approaches for calculating the credit risk. The standardized approach is the simplest approach. In this case, banks can modify the range of risks weights by using credit risk assessments from reputable rating agencies. A second approach is referred to as the internal rating based (IRB) approach. There is also a more advance IRB approach in which even larger part of capital requirements is influenced by the internal estimates. For market risk, there are also simple

and advanced alternative to choose from. For operational risk there are three alternatives: Basic Indicator Approach, Standardized Approach and Advanced Measurement Approach (AMA). In this framework, more advanced approaches imply less capital requirement and more advanced banks are more likely to apply the more advanced approaches (Lind, 2005). Figure 2 shows the detail of the first pillar.

Both Basel I and II require at least 8% ratio of capital to risk-weighted assets. Basel III was released in 2010. Under the Basel III framework the minimum capital requirement has been increased to 10.5%. The implementation of Basel accords varies across countries. Based on a survey conducted by the Financial Stability Institute on 2004 and 2006, eighty-four percent of respondents worldwide intend to apply Basel II framework between 2007 and 2015. Not every country will adopt Basel II framework, but all countries in Asia and Middle East will adopt Basel II framework. The survey also indicates that under Pillar I, most countries have adopted the standardized approach.

2.3.2 Theory of Capital Regulations

This section describes the channels by which capital requirements lead to changes in bank's assets. The aim of minimum capital requirements is to prevent banks from taking excessive risks and provide cushions against losses from shocks. Hanson et al. (2011) argue that by setting higher requirements, regulators can reduce the probability of bank failures. The type of capital can be in different forms as long as it can be used to bear the losses, such as common equity, preferred stocks or subordinated debts. It is also assumed that banks restore the capital ratio immediately after experiencing losses.

Bank can maintain its capital ratio after a negative shock in two manners: 1) by obtaining additional capital from an external source or 2) decreasing asset levels and

leaving the capital unchanged (Please see Figure 3). If only one bank shrinks its assets, for instance, by cutting their credit to maintain its capital ratio, it is likely to have little or no effect on the economy as other banks can make up for the decrease in credit. However, the effect on the overall economy and banking system will be more severe if a large proportion of banks cut their assets at the same time.

Banks are most likely to choose the second option, that is, adjust the asset positions. Adrian and Shin (2009) have documented that during the boom and just before the 2007 financial crisis banks expanded their assets. As the balance sheets expand, banks need to find new borrowers and when good borrowers have been exhausted, bank lend to subprime borrowers. This is the seed of the crisis.

Hanson et al. (2011) argument, that banks tend to change their assets rather than their equity, is supported by Adrian and Shin (2010). Adrian and Shin (2010) show that bank's leverage is pro-cyclical with respect to assets; that is, leverage is high when the asset position is high while banks tend to keep equity relatively constant overtime. The reason banks raise their leverage when the economy is expanding is to increase profits. The pro-cyclicality also means banks cut their lending during recession.

The fire sale model also explains why banks adjust their assets instead of recapitalize (Shleifer and Vishny, 2010). Capital requirement can be used as a stabilizing tool, they restrict balance sheet expansions in booming periods and they also reduce the use of fire sales, where banks are forced to sell their asset at a highly discounted price due to financial distress, in the downturn. During the boom, the bank expands its balance sheet to increase profits. One way to increase the balance sheet or assets is by securitization. If the upturn continues, bank will keep expanding the balance sheets since security prices are

high in this period. Banks can sell the security at a higher price and thus higher profits. Higher capital requirements limit balance sheet expansion (securitization) when the price is above the real value of the security in the upturn. Similarly, in the downturn, lower capital requirements restrict banks from selling their portfolio holdings at a much lower price than their fundamental values (asset fire sales) and reduce contraction of the balance sheets (Shleifer and Vishny, 2010).

The choice between adjusting assets and obtaining new capital depends on the costs as described in the previous paragraphs. Stein (2012) compares the cost of funding for banks and shows that short term debt is less costly than adjusting through equity. Therefore, banks prefer to take on debts instead of recapitalizing. Debt is also safer because in bad times, bank can sell their assets. The possibility of selling these assets and the low cost nature of this activity leads banks to create and obtain funds excessively by creating excessive short-term debts. This funding source is referred to as private money.

Similar to Stein's argument, raising equity capital is more expensive than short or long-term debt financing (Kashyap et al., 2010). Issuing a new public equity can be seen as a negative signal by the market. This is the case because firms tend to sell their stock when it is overvalued, thus this may push their stock prices down. However, the cost of raising equity can be reduced if banks are allowed to grow equity capital from retained earnings overtime (Kashyap et al., 2010).

In sum, altering the assets position is more desirable for banks in need of maintaining their capital ratio because it incurs lower costs than adjusting equity (Shleifer and Vishny, 2010; Stein (2012); Kashyap et al., 2010). Therefore, minimum capital requirements can be utilized to influence the banks' assets positions. The requirements

basically restrict banks' incentive to increase their profits. The lower profitability in the traditional banking sector due to capital requirements have two effects. It reduces traditional banking sector activities and gives incentive for more activity in the shadow banking sector. Thus, higher capital requirements shrink the traditional banking sector and expand the shadow banking sector.

2.4 Data

The study examines the impact of capital requirements on the share of shadow banking assets to total banking assets across countries. It uses shadow bank assets across countries over the 2005 through 2010 period. The assets data are obtained from Orbis database published by Bureau van Dijk (BvD). It covers both listed and unlisted companies around the world. The database contains information on financial data, ownership, stock data, and location. The database is usually used in studies that require financial or non-financial firm-level data.

The original individual bank sample consists of 366,097 individual banks across countries. To get shadow bank assets in a specific country, the individual asset data are aggregated by summing all shadow bank assets in the country. The share of shadow banking asset is defined as the ratio of shadow banking assets to the sum of shadow and traditional banking assets. The final number of observation at the country level are 304.

I define shadow banks by following Acharya et al. (2010). They identify four types of financial institutions according to the SIC codes. The classification is based on the Office of Occupational Safety & Health Administration (OSHA). OSHA categorizes finance, insurance, and real estate under division H which is identified as code 6000 through 6799. This broad division is divided into seven categories; depository institutions (code 6011-

6099), non-depository credit institutions (code 6111-6163), Security and Commodity Brokers, Dealers, Exchanges, and Service (code 6211-6289), Insurance Carriers (code 6311-6399), Insurance Agents, Brokers, and Service (6411), Real Estate (code 6512-6553), Holding and Other Investment Offices (code 6712-6799) (www.osha.gov).

Adrian and Shin (2010) define the shadow banking sector as the sector that contains asset-backed security issuers, finance companies, and funding companies according to the Federal Reserve's Flow of Funds guide. Therefore, based on their market segment I define shadow bank as the non-depository credit institutions (code 6111-6163). This shadow banking sector comprises credit agencies, personal and business credit institutions, and mortgage bankers and brokers. These categories are good proxies for asset-backed securities issuers.

This essay examines how changes in capital requirements affect the relative size of the shadow banking sector. Thus, the main explanatory variable is the minimum capital requirement. The minimum capital requirement data are obtained from the Bank Regulation and Supervision Survey (BRSS) conducted by the World Bank. The data for 2005, 2008, 2009 and 2010 are drawn from BRSS Survey III and IV. The survey was addressed to the head of banking supervision at the central bank or to the head of a separate banking supervision agency. In some countries, the agency delegates completion of the questionnaire to the senior-level staff (Cihak et al. 2012 and www.worldbank.org). The minimum capital requirement variable is taken from one of the survey question, "What was the minimum required risk-based regulatory capital ratio as of end of (year)?"

There are three sets of other explanatory variables: economic development, financial sector and banking sector indicators. The economic development indicators

include GDP growth and openness. Openness is measured by the percentage of total trade to GDP. GDP growth and openness data are obtain from the World Bank. The financial sector development indicators include financial system deposits and stock market capitalization. The data are obtained from Global Financial Development Database (GFDD) World Bank. The financial system deposit is the ratio of demand, time and saving deposits in deposit money banks and other financial institutions to GDP. The stock market capitalization variable is the ratio of total value of all listed shares in a stock market to GDP. These two variables are intended to capture other determinants of shadow banking activity. An economy that has a more advance financial system tends to require more shadow banking services such as services related to securitizations. Thus, financial system deposit and stock market capitalization are used to proxy the depth of financial systems.

The last sets of explanatory variables are the banking sector indicators. These include return on assets (ROA), profit margin, and the country z-score. ROA measures the return in terms of assets. It has been argued that banking sector activities are spurred by the profitability of this sector. ROA and profit margin capture the banking sector profitability, thus they are included as explanatory variables. The ROA data are obtained from Orbis. The country z-score measures the probability of default of a country's banking system. Z-scores compare the buffer of a country's banking system (capitalization and returns) with the volatility of those returns. The data are obtained from GFDD database, World Bank.

Table 1 displays the summary statistics for the variables that are used in the analysis. The total number of observation is 304. All data are at the country level. The data that are originally at the individual bank level such as assets, ROA, and profit margins are

aggregated into the country level. The mean of the minimum capital ratio is 9.3%. It is slightly higher than the minimum requirement suggested by the BIS. Most countries implement 8% minimum capital requirements, while some other countries adopt a ratio higher than 8%. Nigeria set the capital ratio in 2010 to 19%, which is the highest capital ratio in the dataset (Table 2).

2.5 Empirical Model

Previous literature suggests that there are two important factors in determining the relative size of the shadow banking sector. First, the regulatory framework plays a role. Regulations that increase costs for the traditional banking sector encourage the further development of the shadow banking sector. Second, with respect to some activities, the shadow banking sector may have a comparative advantage over the traditional banking sector, driving business toward the less regulated sector (Pozsar et al., 2012 and Acharya et al., 2013). The empirical model incorporates proxies for these indicators for comparative advantage, which are proxied by profit margin and ROA. Profit margin and ROA show how profitable shadow banking sector is in comparison with the traditional sector. We then test the hypothesis whether the regulatory framework, in this case minimum capital requirements, significantly impact the relative size of shadow banking.

To assess the impact of capital requirements on the relative size of the shadow banking sector, we utilize an empirical model of the following form:

$$Y_{it} = \alpha + X_{it}\beta + Z'_{it}\gamma + u_i + \varepsilon_{it} \quad (1)$$

where Y_{it} is the proportion of shadow banking assets to total of traditional and shadow banking assets in country i at time t, X_{it} is minimum capital requirement that is set in country i at time t, and Z'_{it} is a vector of explanatory variables in country i at time t. These

explanatory variables are GDP growth, openness, financial system deposits, stock market capitalization, ROA, profit margin, and z-score. The penultimate term, u_i, denotes unobservable country-specific effects and ε_{it} is the independent and identically distributed error term.

If the regulatory arbitrage view holds, the coefficient on X_{it} will be positive suggesting that the traditional and shadow banking are competing sectors. A more regulated traditional banking sector shifts banking activities into the less regulated shadow banking sector. Therefore, higher capital requirements in the traditional banking sector encourage more shadow banking activities. It is expected that the economic, financial sector, and profitability indicators are positively related to shadow banking activity, while the probability of banking sector default, as measured by country z-scores, is inversely related to the activity.

2.5.1 Endogeneity

Profit margin and ROA are endogenous. There may be reverse causality between assets and ROA (and profit margin), thus it is also difficult to determine the direction of the causal relationship between profit margin and ROA and assets. As an illustration, on one hand large banks that have bigger assets tend get higher margin due to economies of scale. On the other hand, higher profit margin may cause banks to accumulate more assets.

We use pooled least squares and fixed effect approaches to test the regulatory arbitrage hypothesis. In the pooled least square model, both year and country dummies are included. Pooled least squares and fixed effects approaches are appropriate to use because they take into account different economic and financial system characteristics across countries. However, they do not provide straightforward solutions for the endogeneity

problem. We could use instrumental variable method to overcome this problem but finding an instrument is difficult. Therefore, we implement Hausman-Taylor approach to account for endogeneity. The approach does not require external instruments in solving the endogeneity.

This essay uses capital requirement set by the financial regulator or government agencies exogenously in the various countries in our study. In this sense, the capital requirement is exogenous in relation to total assets. Some may argue that capital requirements have the potential to be endogenous. Regulators may set higher minimum capital requirements in order to prevent traditional banks from taking excessive risks, which in turn encourages more shadow banking activities. In addition, risk taking is also one motive for engaging in shadow banking business. Thus, endogeneity may come from the fact that risk affects both shadow banking activities and capital requirements.

To deal with the source of endogeneity, we follow the Hausman-Taylor method (Hausman and Taylor, 1981). The method is basically based on the instrumental variable approach to solve for endogneity. Hausman and Taylor (1981) suggest implementing this approach as follows. The time-varying variables are instrumented by their deviation from the individual mean. This is analogous to the fixed effect within estimator approach. The exogenous variables serve as their own instruments and the time-invariant endogeneous variables are instrumented by the individual average of time-varying exogenous variable. The method has two advantages. First, it allows us to estimate the effect of time-invariant variables. Second, it does not require external instruments for the endogenous variables in the model. Fixed effect estimation will eliminate any time-invariant variables, as it sweep away all the fixed unobserved individual characteristics. Hausman and Taylor also argue

that the fixed effect estimates of time-varying variable will be consistent but inefficient because they are needlessly instrumented. In this paper, we assume capital requirements, profit margin, ROA, and the interaction term of capital requirement are endogenous. Using the Hausman-Taylor approach, these endogenous variables are instrumented by the mean of its deviation from individual mean.

2.6 Results

The regression results are presented in Tables 3 and 4. The numbers in the parentheses are P-values. We use three methods to estimate the impact of capital requirements on the proportion of shadow banking assets to total banking assets. The first two set of regression results that are shown in Table 3. Column 1 of Table 3 presents the pooled least squares estimates and Column 2 of Table 2 shows the fixed effect estimates. We include the interaction of the capital requirement and the level of development. Development is a dummy variable, which takes values of 1 for high-income countries and 0 otherwise. We follow the World Bank to classify[1] countries into high-income and middle/low-income country groups. We grouped the low and middle-income country into one category and high-income countries into the other category. We refer to high-income countries as the developed countries and low and middle-income countries as the developing countries in the rest of the essay.

[1] The World Bank has classified countries according to their income as high-income, middle-income, and low income countries. According to their classification, low-income economies are defined as those with a GNI per capita of $1,035 or less as of July 2013; middle-income economies are those with a GNI per capita of more than $1,036 but less than $12,615; high-income economies are those with a GNI per capita of $12,616 or more (http://data.worldbank.org/news/new-country-classifications).

Column 1 of Table 3 shows that when using the pooled regression results, only the development variable is significant. This coefficient indicates that the share of shadow banking assets are different between developed and developing countries. This positive coefficient indicates that, not surprisingly, the shadow banking sector tend to be higher in developed countries. However, the pooled estimation is not the best specification because it does not account for country and time unobserved fixed effects.

Column 2 of Table 3 reports the fixed effects estimates, in which country and year dummies are included in the estimation. The coefficients of capital requirement and the interaction term are used to test the regulatory arbitrage hypothesis. The capital requirement is not significant but the interaction term of capital requirement and development is at 5% level. The F-test for capital requirement and the interaction term suggest that they are jointly significant with F=56 and p-value 0.000. The interaction term coefficient indicates that on average a one percentage point increase (say an adjustment from 8 percent to 9 percent) in the minimum capital requirement leads to an increase in the share of shadow banking by 0.15 in developed countries relative to developing countries. At the mean, the share of shadow banking assets is 0.13. Shadow banks account for 13 percent of total banking assets, therefore a one percentage point increase in the capital requirement will raise the share to 0.28. The shadow banking system will enlarge so that they account for 28 percent of total banking assets.

Financial system deposit, stock market capitalization, and openness have a significant impact on the share of shadow banking assets. Financial system deposit measures the depth of financial system in a country. It also captures the level of financial development. As expected it has a positive impact on the share of shadow banking assets.

Stock market capitalization, on the other hand, is inversely related to the share of shadow banking assets. Aside from being a proxy of financial sector development, the stock market also provides financial services. We expected stock market capitalization to be positively related to the share of shadow banking assets, the more developed the financial sector the higher the share of shadow banking assets. The inverse relationship may be caused by similarity in the services provided by the stock market and shadow banks. Thus, larger stock market capitalization may be associated with a lower share of shadow banking assets in an economy. Profit margin and ROA are calculated as the average across individual banks' margin and ROA. As can be seen in Table 3, the development variable is dropped since it is fixed overtime. The openness variable is significant at the 5% level, meaning that economies that are more open to international trade are associated with a larger share of shadow banking assets. Thus, international trade activities may require shadow banking services.

For low-income countries, capital requirements do not have an impact on the share of shadow banking assets. These results imply that regulatory arbitrage only takes place in high-income countries and we do not see regulatory arbitrage in developing countries. The shadow banking system in developing countries can be too small relative to total banking activity so that the capital requirements do not have a significant impact on shadow banking. As discussed in the previous sections, shadow banks mainly conduct three functions: maturity, credit, and liquidity transformation. The demand for these functions typically come from countries with a more developed financial sector.

To take care of the endogenous variables, equation (1) is reestimated using the Hausman-Taylor approach. The results are presented in Table 4. All of the time-invariant

variables such as development and all of the country dummies can now be estimated. We assume that the variables that are endogenous are profit margin, ROA, and capital requirement. To control for unobserved fixed factor across countries and year, country and year dummy are included in the estimation but their coefficients are not reported. The estimates are similar to the fixed effect estimates. Development is now significant. Capital requirement does not have a significant impact but the interaction between development and capital requirements does has a significant impact. Jointly, development and the interaction of capital requirement and development are significant at the 5% level[2]. On average, a one percent increase in the minimum capital requirement leads to an increase in the share of shadow bank of 0.15 in high-income countries. Using this estimation method, openness does not have a significant impact on the share of shadow banking assets. Financial system deposit and stock market capitalization both significantly impact the shadow banking share.

2.6.1 Diagnostic Tests

Thus paper uses pooled, fixed effect, and the Hausman-Taylor approach to estimate the regulatory hypothesis. Baltagi et al (2003) proposed a procedure to select the best method among random effect, fixed effect, and Hausman-Taylor estimation. They suggest applying the Hausman test as follows: 1) use Hausman test to choose between random and fixed effect method. In this step, if the Hausman test statistics is not rejected then random effect method is better. 2) Use a second Hausman test to choose between the fixed effect and Hausman-Taylor approach. Choose the Hausman-Taylor approach if the Hausman test

[2] The joint tests yield the same results for all specifications.

statistics is not rejected. 3) If the previous two tests are rejected, the fixed effect estimation is the best method.

The results show that the chi-square statistics is 64 (P-value: 0.000) for the first Hausman test, suggesting that the fixed effect method is preferable to the random effect. The chi-square statistics for the second Hausman test is 13 (P-value: 0.112). This result suggests that Hausman-Taylor method is better than the fixed effect method. Therefore, overall the Hausman-Taylor approach is preferable to the random and fixed effect approach.

2.6.2 Predictive Performance Tests

This section assesses the models by testing their accuracy in predicting the dependent variable. The model selection procedure in the previous section suggests that the Hausman-Taylor approach is the best, therefore in this section we carry out predictive performance tests based on the Hausman-Taylor results. We use three approaches in carrying out the test.

First, compare the density of the dependent variable (proportion of shadow banking assets to total banking assets, Y) and the in-sample prediction of this dependent variable ($\hat{Y}$) to see how well the model has performed in terms of predicting the dependent variable. We use kernel density estimation to compare the density between these two variables (Figure 5). The kernel densities in Figure 5 are estimated using Silverman's optimal bandwidth. The graph suggests that both variables have very similar distribution.

Second, compare the distributions of the dependent variable (Y) and its linear predictions ($\hat{Y}$) using the quantile-quantile (QQ) plot (Figure 6). The QQ plot provides the

plots of the quantiles of Y against the quantiles of $\hat{Y}$. Figure 6 indicates that overall the two distributions are fairly similar. Most data points lie in the diagonal line and only few points, at the tail of the distribution, are slightly above or under the line.

Third, compare the distribution of Y and $\hat{Y}$ and test if they have similar distributions using the two-sample Kolmogorov-Smirnov test. The null hypothesis is that the two samples are drawn from populations with identical distributions. The test indicates that the p-value is 0.9, suggesting that we fail to reject that the two distributions are equal. In sum, the kernel density estimates, the QQ plot, and the two-sample Kolmogorov-Smirnov test imply that our empirical model does a good job in predicting Y.

2.7 Conclusions

The literature on shadow banking has identified important determinants of shadow banking activities. Pozsar et al. (2013) and Acharya et al. (2013) argue that one of the most important determinants is regulatory arbitrage. That is, banks shift their operation away from traditional banking into the less regulated shadow banking sector when traditional banking activities are more heavily regulated. This essay tests empirically the regulatory arbitrage hypothesis.

This essay tests the regulatory arbitrage hypothesis using cross-country banking asset data over the period 2005, 2008, 2009, and 2010. It focuses on minimum capital requirement regulations that are applied by countries in the sample. The shadow banking sector is not subjected to the minimum capital requirements, thus we are able to examine the impact of this regulation on the share of shadow banking asset to total baking assets. The minimum capital requirement and the interaction between the capital requirements and

development are jointly significant. The interaction term suggests that capital requirement has a significantly different impact on developed countries relative to developing countries. Its impact is also economically significant. This result implies that the regulatory arbitrage hypothesis holds in high-income countries relative to the developing countries. This may be because shadow banking provides services for transactions that are more typical in more advanced financial systems. In developed countries, on average, one percentage point increase in the minimum capital requirement leads to 0.15 increase in the share of shadow banking assets relative to the developing countries, raising the share, at the average, from 0.13 to 0.28.

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Table 2.1: Summary Statistics

Variable	Unit	Mean	Std. Dev.	Min	Max
Assets					
Share of shadow bank assets[1]	Ratio	0.13	0.13	0.00005	0.77
Shadow bank assets	billion US$	268	929	0.009	7,570
Traditional bank assets	billion US$	549	1,850	0.007	16,400
Capital regulation					
Minimum capital requirement	ratio	0.093	0.018	0.08	0.19
Economic indicators					
Openness[2]	ratio	0.949	0.581	0.221	5.621
GDP growth	percent	2.617	4.978	-17.955	44.023
Financial sector indicators					
Financial system deposit[3]	ratio	0.649	0.554	0.0437	3.946
Stock market capitalization[4]	ratio	0.564	0.647	0.0037	5.695
Banking sector indicators					
Profit margin[5]	ratio	0.094	0.166	-0.646	0.835
Return on assets (ROA)[6]	ratio	0.013	0.032	-0.244	0.288
Z-score[7]	percent	10.561	11.202	-5.5	70.51
Number of observations	304				

Source: Orbis and World Bank

Note:

1. Share of shadow banking asset=$\frac{Total\ shadow\ bank\ assets}{Total\ shadow\ bank\ asset+Total\ traditional\ bank\ assets}$
2. Openness=$\frac{Trade}{GDP}$
3. The financial system deposit is the ratio of demand, time and saving deposits in deposit money banks and other financial institutions to GDP.
4. The stock market capitalization is the ratio of total value of all listed shares in a stock market to GDP.
5. Profit margin=$\frac{Net\ income}{Revenues}$
6. ROA= $\frac{Net\ income}{Total\ assets}$
7. Z-score measures the probability of default of a country's banking system. Z-score compares the buffer of a country's banking system (capitalization and returns) with the volatility of those returns.

Table 2.2: Distribution of Minimum Capital Requirement Adopted by Countries (in %)

Minimum Capital Requirement	2005	2008	2009	2010
0.08	55.5	53.9	53.0	51.9
0.09	5.5	6.1	4.4	5.7
0.091	0.9	-	-	-
0.1	20.0	21.7	22.6	19.8
0.11	1.8	0.9	0.9	0.9
0.12	14.6	14.8	15.7	17.9
0.13	0.9	-	0.9	-
0.15	0.9	2.6	2.6	2.8
0.19	-	-	-	0.9*
Total	100	100	100	100

Source: BRSS, World Bank

Note: * Nigeria

Table 2.3: Regression Results: Pooled and Fixed Effect

Dependent variable: Proportion of shadow banking	(1)	(2)
Capital requirement	-0.294 (0.549)	0.026 (0.926)
Capital requirement*Development	-2.339 (0.101)	15.247** (0.000)
Development	0.272** (0.025)	_
Profit margin	0.059 (0.188)	-0.005 (0.828)
Return on assets	-0.137 (0.49)	-0.008 (0.919)
Z-score	-0.0002 (0.695)	0.001 (0.470)
Openness	0.002 (0.888)	0.014** (0.001)
GDP growth	-0.0008 (0.553)	0.0004 (0.442)
Financial system deposits	0.018 (0.320)	0.082* (0.096)
Stock market capitalization	-0.022 (0.117)	-0.050** (0.014)
Constant	0.121 (0.021)	-0.452** (0.000)
N	304	304
Adj. R^2	0.12	
R^2 within		0.29
Between		0.16
Overall		0.11
Method of estimation	Pooled least squares	Fixed effect with country and year dummy

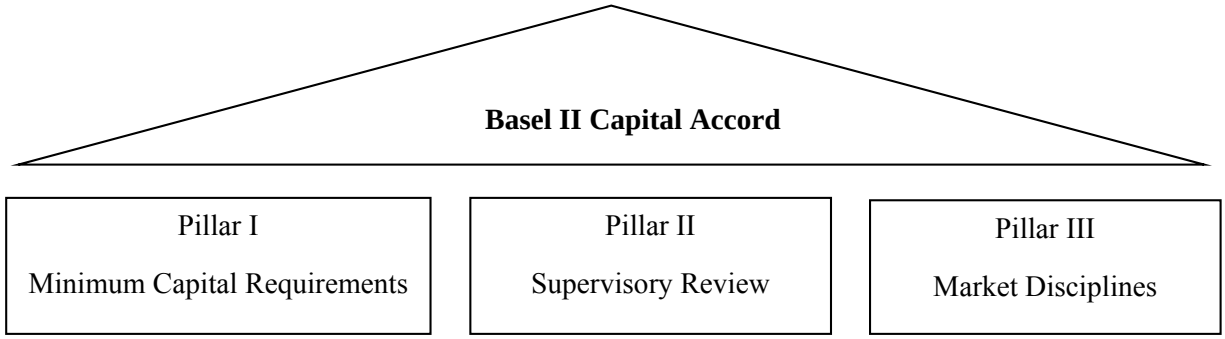
Note: numbers in parentheses are p-value
* indicates statistically significant at 10% level
** indicates statistically significant at 5% level

Table 2.4: Regression Results: Hausman-Taylor

Dependent variable: Proportion of shadow banking	(1)
Time-variant endogenous	
Return on assets	0.009 (0.926)
Profit margin	-0.005 (0.839)
Capital requirement	-0.026 (0.945)
Capital requirement*Development	15.247** (0.000)
Time-invariant exogenous	
Development	-0.846** (0.000)
Time-variant exogenous	
Z-score	0.001 (0.199)
Openness	0.014 (0.110)
GDP growth	0.000 (0.526)
Financial system deposit	0.082** (0.008)
Stock market capitalization	-0.050** (0.000)
Constant	-0.040 (0.719)
N	304
Wald χ^2	3437.6
P-value	0.000
Method of estimation	Hausman-Taylor approach

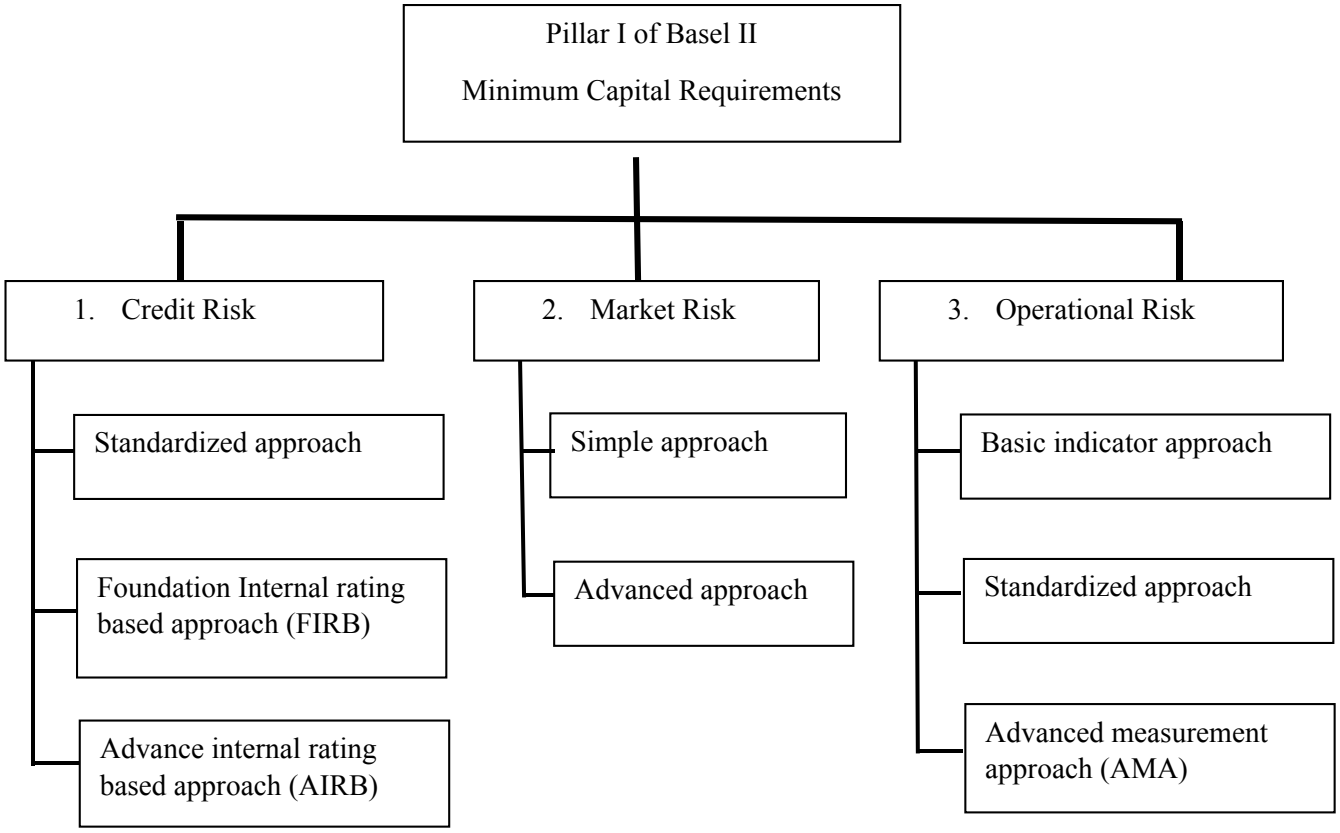
Note: numbers in parentheses are p-value
* indicates statistically significant at 10% level
** indicates statistically significant at 5% level

Figure 2.1: Basel II



Source: Lind (2005)

Figure 2.2: Pillar 1 of Basel II

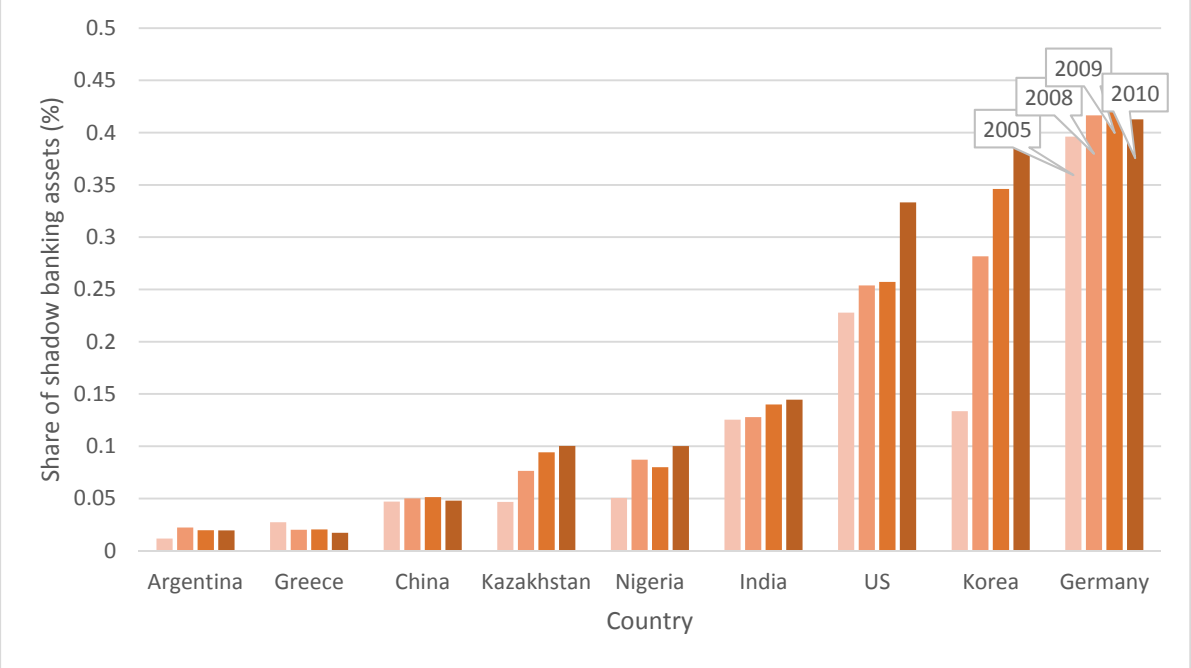


Source: epress.anu.edu.au and Lind (2005)

Figure 2.3: Individual Bank Balance Sheet

Assets	Liabilities
Loans to firms and households	Liabilities to non-bank entities e.g. deposits, securitized debt
Claims on other banks	Liabilities to other banks
	Equity/capital

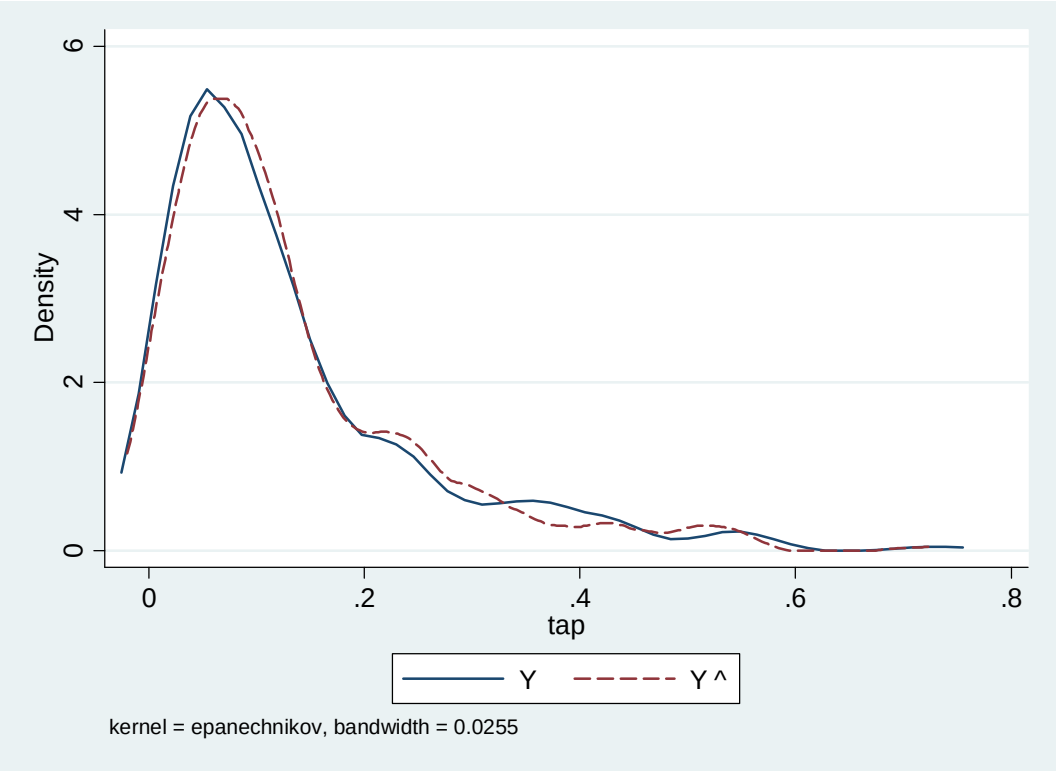
Figure 2.4: Share of Shadow Banking Assets (%)



Source: Orbis

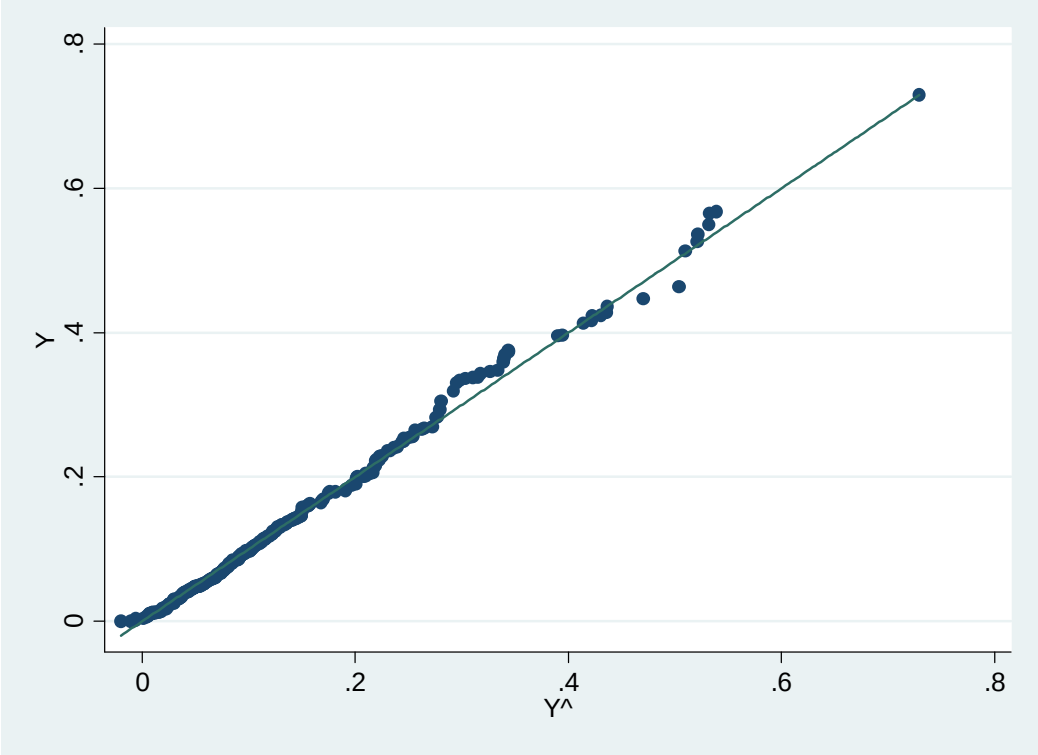
Note: U.S., Germany, Greece, Kazakhstan and Nigeria experienced systemic banking crisis started in 2007 and 2008 (Laeven and Valencia, 2012)

Figure 2.5: Kernel density estimates for Y and $\hat{Y}$



Note: Y is the dependent variable, which is the proportion of shadow banking assets to total banking assets. $\hat{Y}$ is in-sample prediction of Y after Hausman-Taylor regression. The bandwidth is set according to Silverman's rule of thumb.

Figure 2.6: Quantile-quantile (QQ) Plot



Note: Y is the dependent variable, which is the proportion of shadow banking assets to total banking assets. $\hat{Y}$ is in-sample prediction of Y after Hausman-Taylor regression.

CHAPTER 3

THE IMPACT OF BANKING REGULATION ON BANK RISK TAKING

3.1 Introduction

This essay examines the impact of minimum capital requirements on bank risk taking. We focus on whether minimum capital requirements are able to mitigate bank risk taking and assess how these affect both traditional and shadow banks.

Capital regulations are intended to influence bank incentives to take risks. The main objective of minimum capital regulation is to prevent banks from taking excessive risks. To achieve this goal, the Bank for International Settlements (BIS) has proposed minimum capital requirement standards through Basel I, II, and III.

There are, in fact, a number of different theoretical arguments that have been offered about the effectiveness of capital requirements in reducing bank risks. As shown by Kim and Santomero (1988), a risk-based minimum capital requirement is effective for controlling bank risks, as long as the risk weights are chosen optimally. However, in another study, Gennotte and Pyle (1991) suggest the opposite outcome; capital regulations may increase risks. Restrictions will lower future profits and to compensate for this reduction, banks assume more risk by investing more heavily in risky assets in an attempt to increase their profits.

In line with Kim and Santomero (1988), the capital requirements proposed in Basel I, II, and III are risk-based capital standards. Basel I proposes a simple capital standard and it mainly focuses on addressing credit risks. This capital standard was later revised (in 1996) to incorporate market risk. To calculate the risk-based capital ratio Basel I only uses

five weights for different types of assets (BIS, 1998). Basel II improves the framework by incorporating market risk, operational risk, and supervision in addition to credit risk to be more closely aligned with the bank's actual risk. Both Basel I and II require banks to hold total capital to at least 8% of their risk-weighted assets (BIS, 2004). Basel III was initially introduced in 2010 in response to the global financial crisis. It focuses on improving resilience to system wide shocks, improving risk management, and improving bank's transparency. The Basel III capital requirement will be fully implemented in 2019 (BIS, 2011).

While there have been attempts via regulations to safeguard the financial sector, minimum capital regulations only apply to the traditional banking sector. Thus the impact of these regulation will likely differ with respect to risk taking for traditional and shadow banks. As emphasized by Gorton et al (2010) and Pozsar et al (2012) the shadow banking sector played a significant role in the recent global financial crisis. It is argued that the sector employed high risk activities. Therefore we need to consider this sector too when evaluating the impact of regulations on financial stability.

Similar to traditional banks shadow banks provide credit intermediation and conduct maturity, liquidity, and credit transformations (Pozsar et al, 2012). The traditional banking system mainly uses deposits to perform maturity transformation, transforming short-term deposits into long term assets. Shadow banks, instead of taking deposits, rely more on short-term funding such as through repurchasings or repos[3], from corporations, households, or financial institutions (FSB, 2011 and Pozsar et al, 2012). These funds are

[3] In a repo, the borrower sells a security today for a price below the current market price on the understanding that it will buy it back in the future at a pre-agreed price (Adrian and Shin, 2010).

later transformed into longer-term or less liquid assets such as mortgages. They can also be re-invested which will raise the leverage that they assume (FSB, 2011). Thus, shadow banks are subject to risk, especially liquidity risk.

Shadow banks do not have direct access to public sector or central bank backstop and deposit insurance, such as the Fed's discount lending window and FDIC deposit insurance. Shadow banks' reliance on short-term funding and the lack of public guarantees cause the shadow banking sector to be more prone to runs (Pozsar et al., 2012).

In term of regulations, the shadow banking system is relatively less regulated. At the same time, some studies argue that this sector arises in response to changes in banking regulations. These regulations have put substantial restrictions on traditional banks inducing them to sometimes exit this sector and operate as a shadow bank in order to find other profit opportunities (Gorton, 2010). The first essay of this dissertation addressed this issue which is referred to as regulatory arbitrage. Since shadow banks are subject to less regulation they are able to increase the returns of investments by leveraging up more. Banks have an incentive to raise leverage in order to increase their profits (Adrian and Shin, 2009). This may result in increases in risk in the shadow banking sector.

Liquidity or maturity transformations and leverage build up result in higher risk in the shadow banking sector. In addition, different characteristics of traditional and shadow banks may generate differences in risk for the traditional and shadow banking sectors. As John, Saunders, and Senbet (2000) have argued, all banks will have different investment opportunity sets and this implies different optimal level of risk. They further argue that the effectiveness of regulations based on capital ratios may be limited due to the variation in the investment set. In sum, regulations imposed on one sector may vary the investment

opportunities available to the other sector, which in turn affect risk levels. Thus, capital regulations, even if imposed on one sector, may have impacts on both sectors with those impacts differing across sectors.

Broadly, the Financial Stability Board (FSB) defines the shadow banking system as "credit intermediation involving entities and activities outside the regular banking system" (Financial Stability Board, 2011). In this essay shadow banks are identified as Non-depository Credit Institutions (code 61) under the Standard Industrial Classification (SIC) system, as in the first essay. In this study, we focus on non-performing loans (NPLs) and z-score as the measures or proxies of risks. The NPL is an indicator of credit risk while the z-score is interpreted as the probability of bank insolvency. The existing literature lacks research on bank risk in the different banking sectors. Thus, this study aims to fill the gap.

The purpose of this study is to empirically examine the impact of risk-based minimum capital requirements on bank risk outcomes. In addition to the previous research, however, this study aims to focus on the impacts of minimum capital requirements for traditional and shadow baking sectors. Results of the study offer evidence on the effectiveness of minimum capital requirements implementation and explores how risks differ in the two banking sectors.

This study uses banking level data from the Orbis database covering 82 countries. The minimum capital requirement that is used in this study is collected from the Bank Regulation and Supervision Survey (BRSS) conducted by the World Bank. Data for Basel II implementation are collected from the Bank for International Settlements. The empirical evidence indicates that capital regulations, measured by Basel implementation, is negatively related to risks. In this essay two variables of risk are used, which are the ratio

of non-performing loans (NPLs) to gross loans as the ex-post risk and z-score as the ex-ante risk. Basel II is effective in reducing both measures of risk. Other results suggest that traditional and shadow banks differ in term of risks.

The chapter is organized as follows. Section 2 provides a literature review on capital regulation and bank risk. Section 3 explains the data used in the analysis. Section 4 presents the empirical method. Section 5 presents the results and addresses the endogeneity of capital regulation and section 6 concludes.

3.2 Literature Review

A body of research on the relationship between capital and bank risk has focused on analyzing capital regulations, bank risk, and banking stability. Most of this previous research is theoretical in nature. It has generated contradictory conclusions on the relationship between capital regulations and bank risk-taking and on the effectiveness of capital regulation in restraining bank risk-taking. Most existing literature examines risk-taking behavior for the whole banking system, while this study focus on whether traditional and shadow banking sector take on different level of risks in response to minimum capital regulation.

Previous research has reached divergent conclusions regarding the effect of capital regulations on bank risk-taking. Keeley (1990), Keely and Furlong (1990), Furlong and Keely (1989), and Kim and Santomero (1988) demonstrate that capital regulation can be used to reduce bank risk. Kim and Santomero (1988) specifically show that risk-weighted capital requirements are effective. They argue that risk-based minimum capital requirement can be used to control bank risks as long as the risk weights are chosen optimally. Based on their analysis, the weights depends on the expected returns, variance-covariance

structure of the returns, and the upper bound of insolvency risks allowed by the regulators. These three factors are observable and the weights are independent of individual bank preferences, thus risk-weighted capital requirements can be applied.

Keeley (1990) finds that banks with higher capital relative to assets tend to have lower default probabilities. The empirical findings in his paper support this argument, as higher capital leads to lower risk using the two indicators employed in this analysis. Keely and Furlong (1990) and Furlong and Keely (1989) theoretically show that capital regulation may be able to restrain bank asset risks. These studies examine the effect of more stringent capital requirements on bank risk taking by incorporating the role of deposit insurance, hence they only focus on fully insured banks. Furlong and Keely (1989) shows that for fully insured banks the marginal gain from increasing asset risk is positively related to a change in leverage. Since a higher capital ratio is equivalent to lower leverage, more stringent capital regulations lead value-maximizing banks to decrease their asset risk.

To the contrary, other studies have concluded that strengthening capital regulations encourage banks to take more risks, thus, counteracting the purpose of capital controls. Koehn and Santomero (1980) suggest that perhaps the mechanism by which this takes place is that higher minimum capital requirements induce banks to invest in a riskier portfolio of assets. They further formally show that a uniform capital requirement that does not take into account the asset quality is not effective in reducing bank risks. Gennotte and Pyle (1991) incorporate deposit insurance in their study and show that the minimum capital requirement may be positively related to bank risk. Deposit insurance allows banks to provide an almost riskless rate on their deposits. Moreover, the deposit guarantee is basically a transfer from government to banks' shareholders or customers, thereby

constituting an additional profit. This profit will be larger for banks that have higher risk portfolios when those are associated with higher returns. Therefore, to limit the incentive for banks to take higher risks, capital regulation is introduced. A higher capital requirement has two effects on the probability of bankruptcy. It reduces leverage, which reduces the probability of bankruptcy, but it also increases asset risk, which increases the probability of bankruptcy. The magnitude of these opposing effects depends on the ratio of the elasticities of the net present value of investment with respect to the mean and variance of the present value. If the elasticity is independent of the level of assets and if asset returns follows a lognormal distribution, a higher capital requirement leads to higher asset risk.

A study by Calem and Rob (1999) arrive at different conclusions relative to the two lines of research outlined above. They suggest that the relationship between capital position and risk is U-shaped. In contrast to the previous studies, their model incorporate heterogeneity across banks where banks have realized different capital positions. Undercapitalized banks take the highest risk and risk declines as capital rises. After a certain point as capital continue to rise, risk starts to increase. Thus undercapitalized and well-capitalized banks take on more risk than banks with average capital positions. The undercapitalized banks assume more risk because deposit insurance will guarantee the bank in case of bankruptcy while a well-capitalized bank will take on more risk to gain more profits since their probability of bankruptcy is low. VanHoose (2007) argues that the variation in the relationship between capital regulation and bank risk taking is on account of differences in the modeling approach of the different papers. Keeley (1990), Keely and Furlong (1990), Furlong and Keely (1989), Gennotte and Pyle (1991), and Koehn and Santomero (1980) use a portfolio-based approach in their analysis. Calem and Rob (1999)

focus on the incentives regarding the capital regulations. In the next few sections we turn to our empirical analysis of the effects of capital regulation on traditional and shadow banks' risks. We begin by outlining the data in the next section.

3.3 Data

Following Shrieves and Dahl (1992) and Fiordelisi et al. (2011), this study uses non-performing loans (NPLs) to measure risk. NPL is used to measure credit risk and it is an ex-post risk indicator. In this sense, it does not allow authorities to take preventive actions in limiting risks. We also work with an ex-ante risk indicator, which is the z-score. Several papers such as Leaven and Levine (2009) and Kanas (2013) use individual bank z-score as the measure of risk in their studies. To ensure robustness of our results, we utilize several specifications and different data sets. We use both cross-section and pooled data to estimate the relationship between capital regulation and risks.

The non-performing loans indicator variable (NP) is constructed using individual bank data by computing the ratio of non-performing loans (NPLs) to gross loans. The NPLs data cover the period 2004-2013. The z-score are constructed using assets, equity, and return on assets (ROA) over the period of 2003-2012. The z-score is defined as the sum of the ROA and the equity-asset ratio divided by the standard deviation of ROA. The non-performing loans, gross loans, assets, equity, and ROA series for each bank are drawn from Orbis database published by Bureau van Dijk (BvD).

The main explanatory variable is the implementation of Basel II by each country. Basel II is a set of banking recommendations proposed by the Basel Committee on Banking Supervision. The framework focuses on the capital adequacy standard and proposes a risk based framework for measuring capital adequacy. It incorporates market and operational

risk in addition to credit risk previously recommended in Basel I. It was first introduced in 2004 while Basel II was introduced in 1998. Basel I requires banks to calculate the minimum level of capital based on a risk weight for only a few asset categories. Basel II allows banks to use their own risk measurement model to determine the appropriate minimum capital. Banks can choose from several approaches to calculate the required capital.

The data for Basel II implementation are drawn from the Financial Stability Institute (FSI) survey and Bank Regulation and Supervision Survey (BRSS). The FSI survey and BRSS are conducted by the Bank for International Settlements (BIS) and the World Bank respectively. The FSI July 2012 report contains implementation dates of Basel II, 2.5 and III for 131 countries. Some missing data are supplemented from the BRSS. Basel III that sets a higher capital requirement than Basel I and II will be fully implemented by 2019. While Basel 2.5 which is introduced in 2009 is proposed as a response to the global financial crisis. It focuses on revisions of the market risk framework.

Equity data are computed by taking the ratio of total equity to total assets. Revenue growth is calculated using the log difference of revenues. Total equity, total assets, and revenue data are collected from the Orbis database. There are several macroeconomic variables that are included in the empirical models. The stringency and restriction indices are taken from the Barth et al. (2013) database. Barth et al. (2013) construct these indices using BRSS surveys. The stringency index measures overall capital stringency and it is constructed using the response from the BRSS survey. The restriction index is constructed using the response from the BRSS survey on securities, insurance, and real estate activities. These index data are not available annually, over the period 2004-2014, and are only

available for 2005 and 2010. Deposit insurance data are obtained from BRRS. They are the responses to the following question "Is there an explicit deposit insurance protection system for commercial banks?" GDP growth and inflation data are obtained from the World Bank. We use annual percentage growth rate of GDP at market prices based on constant local currency and the annual growth of GDP deflator for inflation.

As in the first essay, traditional and shadow banks are identified according to the standard industrial classification (SIC) following Acharya et al. (2010). The classification is based on the Office of Occupational Safety & Health Administration (OSHA). OSHA categorizes finance, insurance, real estate under division H which is identified as code 6000 through 6799. This broad division is divided into seven categories; depository institutions (code 6011-6099), non-depository credit institutions (code 6111-6163), Security and Commodity Brokers, Dealers, Exchanges, and Service (code 6211-6289), Insurance Carriers (code 6311-6399), Insurance Agents, Brokers, and Service (6411), Real Estate (code 6512-6553), Holding and Other Investment Offices (code 6712-6799) (www.osha.gov).

Adrian and Shin (2010) define the shadow banking sector as the sector that contains asset-backed security issuers, finance companies, and funding companies according to the Federal Reserve's Flow of Funds guide. Therefore, based on their approach I define shadow banks as those that fall under the category non-depository credit institutions (code 6111-6163), whereas I define the traditional banking sector to consist of depository institutions (code 6011-6099).

Table 1 provides summary statistics of the main regression variables for the year 2010, unless otherwise indicated. The sample consists of 1800 banks from 82 countries.

Column 4 of Table 1 presents the average of the variables across banks and countries. The average of NP is 0.05 or 5 percent of total loans are bad loans. Twelve banks have zero NP and 339 banks have NP above 0.5. Out of 1800 observations, about 82 percent or 1610 are traditional banks. The average of bank's z-score is 3.79. This suggests that, on average, profit has to fall by 3.79 times their standard deviation to deplete bank equity. The average of Basel is 0.22, which suggests that 22 percent of the countries or 19 countries have implemented Basel II by 2010.

3.4 Empirical Model

Three empirical models are to be used to determine the effect of capital regulation on risks. We estimate each model using cross-section and pooled data. The cross-section regressions use 2011 NP - and all the right hand side variables are 2010 data. The pooled regressions use two sub-samples of NPLs over 2005-2012 period. In the regression using the z-score as the dependent variable, the sample covers the period 2003-2012. Because of the limited data availability for the restriction index, stringency index, and deposit insurance, some of the regressions do not include these variables. The baseline empirical model that is estimated is as follows:

$$NP_{ij} = \beta_0 + \delta_0 TB_i + \beta_1 Basel_j + \beta_2 Equity_{ij} + \beta_3 Rev_{ij} + \beta_4 Depins_j +$$

$$\beta_5 Stringency_j + \beta_6 Restrict_j + \beta_7 GDP_j + \beta_8 Inflation_j + \varepsilon_{ij} \quad (1)$$

where NP_{ij} measures bank risk for bank i in country j. We use the ratio of non-performing loans (NPLs) to gross loan as the measure of bank risk. Basel is the main independent variable and is indicative of the implementation of Basel II. It is a dummy variable, which takes the value of 1 if Basel II has been implemented. Rev_{ij} is revenue growth for bank i in country j. $Depins_j$ is a dummy for the availability of deposit insurance in country j. It

takes on the value 1 if deposit insurance is available and 0 otherwise. String_j is the index of capital stringency in country j. The index ranges from 0 to 7 and higher values indicate greater stringency. Restrict_j is the index of bank activity restrictions in country j. The index ranges from 3 to 12, with higher values indicative of greater restrictions. These two indices are drawn from (Barth et al., 2013), which are constructed from the BRSS survey conducted by the World Bank. The last two independent variables are GDP growth and inflation. Equation 1 allows traditional and shadow banks to have different level of non-performing loans. The coefficient on TB (δ_0) in equation 1 is interpreted as the expected difference in the incidence of non-performing loans between traditional and shadow banks holding all other variables constant. The coefficient on Basel (β_1) can be interpreted as the effect of Basel implementation on the ex-post measure of risk, NP.

The second class of econometric models substitutes an interaction term between TB and Basel (TB*Basel) in place of the Basel dummy variable. In equation 2 and 3, the interaction term permits us to examine the impact of Basel across two types of banking *sector*. We believe that the impact of Basel depends upon the type of banking sector. TB in equation 2 reflects the difference of NP between traditional and shadow banking sector.

$$NP_{ij} = \beta_0 + \delta_0 TB_i + \delta_1 TB * Basel_j + \beta_2 Equity_{ij} + \beta_3 Rev_{ij} + \beta_4 Depins_j + \beta_5 String_j + \beta_6 Restrict_j + \beta_7 GDP_j + \beta_8 Inflation_j + \varepsilon_{ij} \quad (2)$$

The third empirical model includes TB, Basel, and the interaction term. This specification allows us to see the differential effect of being traditional banks by looking at TB coefficient and the differential effect of implementing Basel from the Basel coefficient.

$$NP_{ij} = \beta_0 + \delta_0 TB_i + \beta_1 Basel_j + \delta_1 TB * Basel_j + \beta_2 Equity_{ij} + \beta_3 Rev_{ij} + \beta_4 Depins_j + \beta_5 String_j + \beta_6 Restrict_j + \beta_7 GDP_j + \beta_8 Inflation_j + \varepsilon_{ij} \quad (3)$$

Another variable to proxy risk that is used is the bank's z-score. Previous literature, for example Koehn and Santomero (1980) among others, use the z-score as one measure of bank insolvency. The z-score is derived by applying the Bienayme-Chebyshev inequality to find the upper bound of bankruptcy probability (Boyd et al. 1993).

Boyd et al. (1993) define bank bankruptcy as "situation in which equity is insufficient to offset losses" (p. 48) or m<–E, where m is total accounting income after taxes and E is total accounting equity. They define $r = \frac{m}{assets}$ and $= \frac{-E}{assets}$. If r is normally distributed, the probability of bankruptcy can be written as

$$P(r < k) = \int_{-\infty}^{z} N(0,1)dz,$$

$$z = \frac{(k - \rho)}{\sigma}$$

where ρ and σ are, respectively, the true mean and standard deviation of r distribution respectively. The upper bound of the probability of bankruptcy is z and by Bienayme-Chebyshev inequality:

$$P(r \leq k) \leq \left[\frac{\sigma}{\rho - k}\right]^2 = \frac{1}{z^2} \qquad (4)$$

In this set up z can be interpreted as "the number of standard deviation below mean by which profit must fall in order to eliminate equity" (p.48).

Bertay, et.al. (2013) interpret the z-score as the probability of insolvency. Bank insolvency can be defined as (CAR+ROA)<0 (Strobl, 2014), where CAR is the capital asset ratio and ROA is the return on assets. Rearrange the definition of insolvency we get the following equation

$$ROA < -CAR$$

By Bienayme-Chebyshev inequality the probability of insolvency can be written as

$$P(ROA \leq -CAR) \leq \left[\frac{\sigma_{ROA}}{\mu_{ROA} + CAR}\right]^2 = \frac{1}{z^2}$$

$$z = \frac{\mu_{ROA}+CAR}{\sigma_{ROA}} \qquad (5)$$

where μ_{ROA} is the mean of ROA and σ_{ROA} is the standard deviation ROA. A higher z-score reflects a lower probability of insolvency. It indicates "the number of standard deviations that a bank's rate of return on assets can fall in a single period before it becomes insolvent" (p.535). The z-score in this paper is defined as following Bertay, et.al. (2013), which is derived from equation 5

$$z - score = \frac{\mu CAR+\mu ROA}{\sigma ROA} \qquad (6)$$

where μCAR is the mean of equity to asset ratio or leverage.

It has been argued that capital regulation and risks may be endogenous. The capital regulation basically requires banks to allocate minimum capital to provide a buffer against bank losses and discourage banks from taking excessive risks. Thus, on the one hand the amount of capital is dependent on risks while on the other hand, the amount of risks a banks can take may depend on its level of capital. The empirical models, which includes Basel in the right hand side, will be endogenous. We address the endogeneity with an instrumental variable (IV) approach in section 5.1.

3.4.1 Endogeneity

Basel may be endogenous. Basel is endogenous due to reverse causality. Countries may apply Basel I or II because they observe banks taking on excessive risk and wish to stop that behavior. The relationship between risk and capital is also hard to identify because, the level of risk a bank can undertake is affected by its capital level and capital that is needed is influence the amount of risk that a bank wants to undertake. Thus, Basel

implementation and risk may be endogenous. Basel II aims to better align minimum capital requirements with risk. Basel II consists of three pillars, Pillar I outlines the mechanism for calculating minimum regulatory capital. This first pillar includes calculations for credit risk and operational risk. Regulatory capital for credit risk can be calculated using the standardized approach or internal rating based (IRB) approach. The IRB approach allows institutions to use their internal measures of credit risk. Institutions which use advanced IRB are allowed to use their own estimates of the borrower's probability of default (BIS, 2005). Basel is a dummy variable, which takes a value of 1 if the country has implemented II by a specific year and 0 otherwise. For instrumenting Basel implementation, we are looking for macroeconomic variables that are related to Basel implementation but are uncorrelated with the ratio of non-performing loans to gross loans (NP). Possible instruments are a country's z-score.

National z-score data are taken from Global Financial Development Database (GFDD) from the World Bank. The z-score is intended to captures the probability of default of a country's banking system. It compares the buffer of a country's banking system (capitalization and returns) with the volatility of those returns. It is calculated as (ROA+(equity/assets))/sd(ROA); sd(ROA) is the standard deviation of return on assets (ROA). ROA, equity, and assets are country-level aggregate figures. Such aggregate level data are exogenous to any specific banks, thus any specific bank's NP. However, it has a very close relationship with Basel I or II implementation because the z-score is an indicator of probability of default of a country's banking system, thus the higher the probability of default the more likely a country will implement Basel I or II. Financial system deposit measures the depth of financial system. It is the total value of demand, time and saving

deposits at domestic deposit money banks as a share of GDP. Deposit money banks comprise commercial banks and other financial institutions that accept transferable deposits, such as demand deposits.

Revenue growth and equity are endogenous because of reverse causality. The causal relationship can go in both directions. NP, equity, and revenue growth are some bank performance indicators. Banks with higher equity and revenue growth tend to have lower NP and vice versa. It is not clear whether low NP lead to higher equity and revenue growth or the opposite. It is possible that NP affects equity and revenue growth rather than the other way around. That is, high revenue growth and equity may induce banks to do more monitoring of their clients and select less risky customers, which ultimately reduces the probability of loan defaults. On the other hand, low levels of NP may lead to higher revenue growth of banks. Common factors may affect all of these three variables at the same time, such as business cycles or other macroeconomic shocks. To account for the impact of these factors we included two macroeconomic indicators, inflation and GDP growth, as explanatory variables.

Two separate solutions to deal with the endogeneity problem of Basel implementation are to use simultaneous equation and instrumental variable (IV) approach. Equation that suffer from reverse causality can be fixed using simultaneous equation method, however this method requires the system of the equation to be exactly identified. The second method requires good instruments for Basel implementation.

This essay utilizes instrumental variable (IV) approach to deal with the endogeneity of Basel implementation. As suggested by Angrist and Pischke (2009), multiple endogenous variables in one regression equation are difficult to identify and the results are

also hard to interpret. Thus, we start with an equation and assume it only contains one endogenous variable at a time. First, we analyze an equation that contains Basel implementation as the endogenous variable, next we consider the interaction between Basel implementation and TB as the endogenous variable.

The second concern of the instrumental variable (IV) approach is that the endogenous variable, Basel implementation, is a categorical variable. It takes the value of 1 if a specific country has implemented Basel II at a certain year and it take the value of 0 if otherwise. The instrument, on the other hand, the national level z-score, is a continuous variable. We follow procedures as suggested by Wooldridge (2002) to deal with this type of endogenous variable. He suggests using the method to estimate the average treatment effect (ATE) using IV. Heckman (1978) refers to it as a dummy endogenous variable model. The model can be written as follows

$$y = \delta_0 + \alpha w + \boldsymbol{x}\boldsymbol{\beta}_0 + u_0 \quad (7)$$

x is the vector of covariates, w is binary treatment indicator, where w=1 denotes treatment and w=0 otherwise, and α is the average treatment effect (ATE). This equation can be estimated using 2 stage least squares (2SLS) method. Based on Wooldridge (2002), the optimal IV for w is $E(w|\boldsymbol{x}, \boldsymbol{z}) = G(\boldsymbol{x}, \boldsymbol{z}; \gamma)$, therefore a two-step IV procedure can be used, where $\boldsymbol{z}$ is the vector of instruments. First, estimate model $P(w = 1|\boldsymbol{x}, \boldsymbol{z}) = G(\boldsymbol{x}, \boldsymbol{z}; \gamma)$ using maximum likelihood and calculate the fitted probabilities $\widehat{G}_t$. Second, estimate equation (8) using instrumental variable (IV) method using instruments 1, $\widehat{G}_t$, and $\boldsymbol{x_i}$. Wooldridge (2002) shows that 2SLS estimators and standards errors are asymptotically valid, and IV estimator are asymptotically efficient in the class of estimator where IVs are function of $(\boldsymbol{x_i}, \boldsymbol{z_i})$, as long as $E(v_0|\boldsymbol{x})$ is linear in x, the error u_0 has zero conditional mean

or $E(u_0|\boldsymbol{x},\boldsymbol{z}) = 0$, and $Var(u_0|\boldsymbol{x},\boldsymbol{z})$ is constant. In our case, the first stage will be regressing Basel implementation on national level z-score as the instrument and all the explanatory variables. The second stage, use the predicted probability after the probit regression from the first stage by IV and use the predicted probability from the first stage and other control as the instrument to estimate the NP equation (equation 1, 2, or 3).

Overall, the results shows that some of the least squares estimates differ from the IV estimates. Some estimates that are significant in the least squares regressions become not significant in the IV regressions and vice versa. The I.V. regression results are presented in Table 2 to Table 5 in columns 4 to 6 In column 4 Basel is instrumented by national level z-score, in column 5 the interaction term, TB*Basel, is instrumented with the interaction between TB and national level z-score, and in column 6 Basel and the interaction term are instrumented by national level z-score and the interaction between TB and national level z-score.

3.5 Results

The regression results are presented in Table 2 through Table 5. The ratio of Non-performing loans to gross loans (NP) and individual bank z-scores are used as alternative measures of risk. The numbers in the parentheses are P-values. The least square method is used to estimate the impact of capital requirement implementation on bank risk. To deal with the presence of endogeneity, the instrumental variable (IV) approached is used. All the standard errors from the IV method have been corrected (as robust standard errors). The second way to minimize potential endogeneity is by using the lag values of the independent variables. We incorporate the lag independent variable method as shown in Table 2 to 4. Non-performing loans (NP) and z-score are used as the proxies of risks.

Table 2 shows the regression result using cross-sectional data. The dependent variable is non-performing loans (NP) in 2011 and all the independent variables use 2010 data to minimize the potential endogeneity. The independent variables in the regression are as follows. TB is a dummy variable and it takes the value of 1 for traditional banks and 0 otherwise. Basel is a dummy variable taking the value of 1 if the country applied Basel II by the year 2010 and 0 otherwise. Equity is the ratio of equity to total assets. The other control variables are revenue growth, deposit insurance, stringency index, restriction index, GDP growth, and inflation. Column 2, 3, 5, and 6 in Table 2 includes interaction terms between TB and Basel.

In the first column of Table2 (without interaction terms), Basel is negative and significant at the 1% level. It indicates that banks in countries that implement Basel II by the year 2010 experienced less ex-post risk as shown by lower NP. Revenue growth, bank's activity restriction index, and deposit insurance are negatively correlated with NP, as expected. Equity is positively correlated with NP. Ogler and Taggart (1983) argue that banks optimize their capital by evaluating the benefit from debt financing (because interests are tax deductible) and the cost associated with it (higher debts increases bankruptcy costs). The value of bankruptcy costs is an increasing function of the probability of bankruptcy. Therefore, banks tend to increase capital level when they increase asset portfolio risks. This relationship is relevant for banks with capital positions higher than required by the regulation. As capital is closely related to equity[4], we may argue that equity will also be positively related to risks. Since tax regulations vary across countries, this channel is only true for some countries. Other explanation for this is agency

[4] Equity is equal to capital if capital is defined as total asset minus liabilities (tier 1 capital).

theory (Saunders et al., 1990). In this context, managers act as agents of the stockholders. Managers lose a great deal in the event of bank insolvency, consequently they have the incentive to take risks below the level desired by the stockholders. As a result, for banks with high risk, the managers will compensate by setting higher capital.

Deposit insurance has a negative impact on NP suggesting that deposit insurance does not seem to encourage banks to take excessive risks. Some have argued that insurance can be considered as a downfall gain for the banks, as a result it leads banks to undertake inefficient investment and thus increases risks (Gennotte and Pyle, 1991). However, Keely and Furlong (1990) argue that one of the objectives of capital regulation is to reduce risk induced by the deposit insurance. They further show that capital regulation is effective in limiting risk even in the presence of deposit insurance. Inflation is positively correlated with NP indicating that higher inflation is associated with higher NP. Higher inflation may result in an unfavorable economic environment causing banks' customers to have difficulties in meeting their repayment to the banks.

The second column of Table 2 shows that NP is 2.58 percentage points lower under Basel II for traditional banks. TB and the interaction term of TB and Basel are jointly significant at 1% level. The third column of Table 2 includes the interaction terms. Using column 3 of Table 2, the effect of Basel on NP is 0.0514-0.0766=-0.0252 suggesting that Basel leads to lower NP in traditional banks by 2.5 percentage points, while increases NP by 5.1 percentage points in the shadow banking sector..

Tables 3 and 4 estimate the regression results using pooled data. The results in Table 3 use 2-period pooled data of NP in 2006 and 2011. We only use 2006 and 2011 sample because of data availability of the explanatory variables. The specification in Table

3 uses the same explanatory variables as in Table 2. Table 4 uses 8-period pooled data, the dependent variable is NP from 2005-2012 and all the explanatory variables are from 2004-2011. Since the deposit insurance, restriction index, and stringency index are not available for every year, these indices are not included in this specification.

Table 5 shows the regression results where the dependent variable is the individual bank z-score. The z-score requires using the mean and standard deviation of ROA. Thus, the z-score is constructed using data over the period 2004-2007 and 2008-2012. The z-score can be interpreted as the probability of default over the period 2004-2007 and 2008-2012 or how far bank's rate of return on assets can fall before it becomes insolvent. For the explanatory variables (equity, revenue growth, GDP growth, and inflation) we use 2004 and 2008 data since the impacts of these variables on the probability of default might take time before they become effective. We use 2001 and 2005 data for deposit insurance, stringency index, and restriction index because these variables are only available for 2001 and 2005 during the regression period. Table 5 column 1 and 3 shows that traditional banks have higher z-score, which suggest a lower probability of default relative to the shadow banks. In column 2 Basel is positive suggesting that Basel implementation leads to higher z- score or lower probability of default.

The following section will discuss the IV estimates. Table 2 to 4 present regression results using NP as the proxy of risks. Column 4 of Table 2 shows that Basel reduces NP by 0.2047 relative to NP of banks in countries that have not implemented Basel. Similarly, the results in column 5 of Table 2 also suggest that the implementation of Basel reduces NP in the traditional banking sector by 0.1107 or by 11.07 percentage points relative to the NP of the shadow banks.

The IV estimates in column 4 in Table 3 suggest that we expect to see 0.0153 more NP in traditional than in the shadow banking sector. Using the same column, Basel leads to lower risk, which is measured by the NP, by 0.2031. Similar to this results, column 5 suggests that Basel implementation in traditional banking system leads 0.1703 lower risk in traditional banking sector. Table 4 column 4 and 5 also suggest similar results.

Column 6 of Table 3 and column 6 of Table 4 allow us to compare the NP of traditional banks which implement Basel to those which do not. Using column 6 of Table 3, the effect of Basel on traditional banks is -0.310, calculated as -0.0794-0.956+0.7253, while the effect for traditional banks that do not implement Basel is -0.0794. Using column 6 of Table 4, the effect of Basel on traditional banks is -0.0881, calculated as -0.1224-1.003+0.7927, while the effect for traditional banks that do not implement Basel is -0.1224. Therefore, the results from Table 3 suggest that in traditional banking sector, Basel leads to lower NP while Table 4 suggest otherwise.

The results using bank z-score as the proxy for risk are presented in Table 5. In column 4, where the interaction term is not included, Basel increases z-score by 7.5382. This suggests that Basel implementation reduces the probability of bank default. Traditional banks tend to have higher z-score by 0.567 or lower probability of default relative to the shadow banks. As discussed the previous section, z-score is an ex-ante risk indicator while NP is more of an ex-post risk indicator. Column 5 of Table 5 also suggest similar results, the z-score for traditional bank 5.2169 higher in response to Basel implementation.

After estimating the IV regressions we test if the endogenous variables are actually exogenous. We test the hypothesis using the Durbin and Wu-Hausman test. The null

hypothesis is that the variables are exogeneous. The results indicates that all the variables that are assumed to be endogenous are indeed endogeneous in all regression specifications[5].

3.6 Conclusions

Capital provides a cushion to absorb unexpected loss or risk for banks so that they can continue their operation. Basel I, II, and III are a set of capital regulation proposed by the Bank for International Settlements (BIS) to set an international standard on capital adequacy. Basel I was introduced in 1988 and focuses only on credit risk. The first accord was then revised to take into account the new developments in the banking sector. Basel II incorporate more risk categories to better align with the actual bank portfolio. Previous literature highlights that the impact of capital regulation is mixed, that capital may or may not be effective in limiting bank risk. Other development in the banking sector in the last decade is the emergence of shadow banking sectors. This sector is believed to have significantly contributed to the 2009 financial crisis and is associated with systemic risk. This paper examines the effect of Basel II on bank risks in the traditional and shadow banking sectors.

In this paper we examine the impact of Basel II implementation on bank's ex-post and ex-ante risk indicators. The ex-post risk indicator that is used is the ratio of non-performing loans to gross loans (NP) and the ex-ante risk indicators used is bank's z-score. We find that Basel II induces lower risks, as measured by NP and z-scores. It leads to lower NP and higher z-scores (signifying a lower probability of bank default). Comparing the two banking sectors, the results are mixed. Using NP as the measure of risk, traditional

[5] The null hypothesis is that the variable is exogenous. The test results indicate that all of the p-values are less or equal to 0.01 or we reject that the variables are exogenous.

banks tend to have higher level of NP, or higher risk, relative to the shadow banks. However, using z-score as the risk measure the results shows that traditional banks tend to have lower probability of default, or lower risk, relative to the shadow banks.

In sum, the two banking sectors exhibit different risk profiles. Traditional banking sector tends to have lower ex-ante risk while it has higher ex-post risk relative to the shadow baking sector. Nevertheless, Basel II implementation is effective in reducing both ex-post and ex-ante risk in the traditional banking sector.

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Table 3.1: Summary Statistics (for the year 2010)

Variable	Unit	No. of observation	Mean	Std. Dev.	Min	Max
	(1)	(2)	(4)	(5)	(6)	(7)
Bank level						
Non-performing loans*	Ratio	1800	0.05	0.08	0	0.94
TB		1800	0.89	0.31	0	1
Equity	Ratio	1800	0.16	0.14	0.001	0.99
Revenue growth	Percent	1800	0.04	0.64	-5.39	3.85
Bank z-score**		13908	3.78	6.94	-431.88	185.84
Country level						
Basel		82	0.22	0.42	0	1
Restriction index		82	6.95	1.92	3	12
Stringency index		82	5.18	1.51	2	7
Deposit insurance		82	0.83	0.38	0	1
Inflation	Percent	82	6.86	12.64	-2.32	102.33
GDP growth	Percent	82	3.83	3.82	-9.53	16.73
Country z-score		80	15.79	11.72	-2.61	46.35

*Non-performing loans 2011

**Bank's z-score over 2008-2012

This table reports descriptive statistics of the main regression variables. Statistics based on annual data for the year 2010, unless otherwise indicated. Sample consist of 1760 banks from 76 countries, if available. Non-performing loans (NP) is computed as the bank's ratio of on total non-performing loans to total gross loans. TB is a dummy variable that takes a value of 1 if the bank is a traditional bank and 0 if it shadow bank. Equity is the ratio of total equity total assets. Revenue growth is the annual growth of total revenues of the banks. Bank z-score is the bank's return on assets (ROA) plus the capital asset ratio (CAR) divided by the standard deviation of ROA over the period 2008-2012. Basel is a dummy variable that it takes a value of 1 if the country has implemented Basel by 2010 and 0 otherwise. Restriction index is an index of activity restriction. Stringency index is an index of capital stringency. Deposit insurance is a dummy variable that it takes a value of 1 if the country has the explicit deposit insurance and zero otherwise. Inflation is the annual growth of GDP deflator. GDP growth is annual growth of GDP. Country z-score is the country's z-score.

Table 3.2: Least Squares and Instrumental Variable (IV) Estimates of Basel on NP: Cross-section

Method: least squares				Method: IV 2SLS		
	1	**2**	**3**	**4**	**5**	**6**
	NP2011	**NP2011**	**NP2011**	**NP2011**	**NP2011**	**NP2011**
TB	-0.0048	-0.0013	0.0058	-0.0061		-0.291
	(0.409)	(0.829)	(0.351)	(0.421)		(0.445)
Basel	-0.0162		0.0514	-0.2047		-2.5655
	(0.004)***		(0.001)***	(0.000)***		(0.429)
TB*Basel		-0.0258	-0.0766		-0.1107	1.9721
		(0.000)***	(0.000)***		(0.000)***	(0.453)
Equity	0.1682	0.1654	0.164	0.134	0.1137	0.1114
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.195)
Revenue growth	-0.0161	-0.0159	-0.0161	-0.0095	-0.0125	0.0115
	(0.000)***	(0.000)***	(0.000)***	(0.021)**	(0.000)***	(0.739)
Deposit insurance	-0.0199	-0.0222	-0.0192	-0.0941	-0.0511	-0.3622
	(0.011)**	(0.004)***	(0.013)**	(0.000)***	(0.000)***	(0.366)
Stringency index	-0.0004	-0.0004	-0.0007	0.0025	-0.0003	0.0207
	(0.775	(0.784)	(0.641)	(0.25)	(0.869)	(0.445)
Restriction index	-0.0069	-0.0071	-0.0069	-0.0131	-0.0107	-0.0341
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.289)
GDP growth	-0.0005	-0.0005	-0.0005	-0.0003	-0.0001	0.0009
	(0.507)	(0.508)	(0.492)	(0.775)	(0.911)	(0.824)
Inflation	0.0005	0.0005	0.0005	0.0004	0.0005	-0.0002
	(0.022)**	(0.022)**	(0.020)**	(0.191)	(0.029)**	(0.864)
Constant	0.1017	0.1035	0.0939	0.229	0.1708	0.8615
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.347)
Observations	1,800	1,800	1,800	1,777	1,591	1,777
R-squared	0.18	0.19	0.19	Basel	TB*Basel	Basel, TB*Basel
p-values in parentheses				z-score (national)	TB*z-score (national)	z-score, TB*z-score (national)
* significant at 10%; ** significant at 5%; *** significant at 1%						

This table presents regression results of indicators of bank risk (non-performing loans) on capital regulation (Basel) and other bank-specific and macroeconomic variables. Column 1 to 3 present the results using least square method and column 4 to 6 present the results using instrumental variable (IV) method. The dependent variable is non-performing loans 2011 and all the independent variables are for the year 2010. Dependent variable is non-performing loans (NP), computed as the bank's ratio of on total non-performing loans to total gross loans. TB is a dummy variable that takes a value of 1 if the bank is a traditional bank and 0 if it shadow bank. Basel is a dummy variable that it takes a value of 1 if the country has implemented Basel by 2010 and 0 otherwise. TB*Basel is the interaction between TB and Basel. Equity is the ratio of total equity total assets. Revenue growth is the annual growth of total revenues of the banks. Deposit insurance is a dummy variable that it takes a value of 1 if the country has the explicit deposit insurance and zero otherwise. Stringency index is an index of capital stringency. Restriction index is an index of activity restriction. GDP growth is annual

growth of GDP. Inflation is the annual growth of GDP deflator. Z-score is the country's z-score (national level z-score). TB*z-score is the interaction between TB and country z-score.

Table 3.3: Least Squares and Instrumental Variable (IV) Estimates of Basel on NP: Pooled 2-period

Method: least squares				Method: IV 2SLS		
	1	**2**	**3**	**4**	**5**	**6**
	NP	**NP**	**NP**	**NP**	**NP**	**NP**
TB	0.0004	0.0032	0.0091	0.0004		-0.0794
	(0.917)	(0.392)	(0.018)**	(0.913)		(0.083)*
Basel	-0.015		0.0553	-0.1311		-0.956
	(0.000)***		(0.000)***	(0.000)***		(0.049)**
TB*Basel		-0.025	-0.0798		-0.0833	0.7253
		(0.000)***	(0.000)***		(0.000)***	(0.078)*
Equity	0.1684	0.1661	0.1645	0.1538	0.1331	0.1615
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Revenue growth	-0.0174	-0.0172	-0.0174	-0.014	-0.015	-0.0083
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.127)
Deposit insurance	-0.0231	-0.025	-0.0223	-0.0583	-0.0385	-0.1228
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.005)***
Stringency index	0.0003	0.0004	0.0001	0.0024	0.0011	0.0076
	(0.713)	(0.654)	(0.873)	(0.026)**	(0.273)	(0.043)**
Restriction index	-0.0059	-0.0061	-0.006	-0.0092	-0.0088	-0.0144
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
GDP growth	-0.0008	-0.0008	-0.0008	-0.0007	-0.0005	-0.0004
	(0.11)	(0.108)	(0.099)*	(0.181)	(0.334)	(0.686)
Inflation	0.0007	0.0007	0.0007	0.0007	0.0008	0.0007
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.015)**
Constant	0.0879	0.0895	0.0814	0.1477	0.1297	0.3044
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.002)***
Observations	4,018	4,018	4,018	3,991	3,510	3,991
R-squared	0.17	0.17	0.18	Instrumented: Basel	TB*Basel	Basel, TB*Basel
p-values in parentheses * significant at 10%; ** significant at 5%; *** significant at 1%				Instruments: z-score (national)	TB*z-score(national)	z-score, TB*z-score (national)

This table presents regression results of indicators of bank risk (non-performing loans) on capital regulation (Basel) and other bank-specific and macroeconomic variables. Column 1 to 3 present the results using least square method and column 4 to 6 present the results using instrumental variable (IV) method. The dependent variable is non-performing loans 2006 and 2011. The independent variables that are used are for the year 2005 and 2010. Dependent variable is non-performing loans (NP), computed as the bank's ratio of on total non-performing loans to total gross loans. TB is a dummy variable that takes a value of 1 if the bank is a traditional bank and 0 if it shadow bank. Basel is a dummy variable that it takes a value of 1 if the country has implemented Basel and 0 otherwise. TB*Basel is the interaction between TB and Basel. Equity is the ratio of total equity total assets. Revenue growth is the annual growth of total revenues of the banks. Deposit insurance is a dummy variable that it takes a value of 1 if the country has the explicit deposit insurance and zero otherwise. Stringency index is an index of capital stringency. Restriction index is an index of activity

restriction. GDP growth is annual growth of GDP. Inflation is the annual growth of GDP deflator. Z-score is the country's z-score (national level z-score). TB*z-score is the interaction between TB and country z-score.

Table 3.4: Least Squares and Instrumental Variable (IV) Estimates of Basel on NP: Pooled 8-period

Method: least squares					Method: IV 2SLS		
	1	**2**	**3**		**4**	**5**	**6**
	NP	**NP**	**NP**		**NP**	**NP**	**NP**
TB	-0.0008	0.0002	0.0024		0.0153		-0.1224
	(0.204)	(0.732)	(0.001)***		(0.000)***		(0.000)***
Basel	-0.0032		0.0124		-0.2031		-1.0032
	(0.000)***		(0.000)***		(0.000)***		(0.000)***
TB*Basel		-0.0052	-0.0176			-0.1703	0.7927
		(0.000)***	(0.000)***			(0.000)***	(0.000)***
Equity	0.1568	0.1568	0.1568		0.1552	0.1402	0.1541
	(0.000)***	(0.000)***	(0.000)***		(0.000)***	(0.000)***	(0.000)***
Revenue growth	-0.0106	-0.0107	-0.0106		-0.0277	-0.0248	-0.0319
	(0.000)***	(0.000)***	(0.000)***		(0.000)***	(0.000)***	(0.000)***
GDP growth	-0.0014	-0.0014	-0.0014		-0.0011	-0.0013	-0.0013
	(0.000)***	(0.000)***	(0.000)***		(0.000)***	(0.000)***	(0.000)***
Inflation	0.002	0.002	0.002		0.0022	0.0025	0.0023
	(0.000)***	(0.000)***	(0.000)***		(0.000)***	(0.000)***	(0.000)***
Constant	0.0195	0.0189	0.0167		0.0547	0.0622	0.1957
	(0.000)***	(0.000)***	(0.000)***		(0.000)***	(0.000)***	(0.000)***
Observations	88,112	88,112	88,112	Observations	87,759	75,756	87,759
R-squared	0.14	0.14	0.14	Instrumented:	Basel	TB*Basel	Basel, TB*Basel
				Instruments:	z-score (national)	TB*z-score(national)	z-score, TB*z-score (national)

p-values in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

This table presents regression results of indicators of bank risk (non-performing loans) on capital regulation (Basel) and other bank-specific and macroeconomic variables. Column 1 to 3 present the results using least square method and column 4 to 6 present the results using instrumental variable (IV) method. The dependent variable is non-performing loans from the year 2005 to 2012. The independent variables that are used are from the year 2004 -2011. Dependent variable is non-performing loans (NP), computed as the bank's ratio of on total non-performing loans to total gross loans. TB is a dummy variable that takes a value of 1 if the bank is a traditional bank and 0 if it shadow bank. Basel is a dummy variable that it takes a value of 1 if the country has implemented Basel and 0 otherwise. TB*Basel is the interaction between TB and Basel. Equity is the ratio of total equity total assets. Revenue growth is the annual growth of total revenues of the banks. GDP growth is annual growth of GDP. Inflation is the annual growth of GDP deflator. Z-score is the country's z-score (national level z-score). TB*z-score is the interaction between TB and country z-score.

Table 3.5: Least Squares and Instrumental Variable (IV) Estimates of Basel on Z-score

Method: least squares				Method: IV 2SLS		
	1	**2**	**3**	**4**	**5**	**6**
	Bank z-score	**Bank z-score**	**Bank z-score**	**Bank z-score**	**Bank z-score**	**Bank z-score**
TB	0.4754	0.4211	0.4339	0.567		0.7622
	(0.065)*	(0.103)	(0.099)*	(0.030)**		(0.015)**
Basel	1.1024		0.2991	7.5382		11.4849
	(0.052)*		(0.794)	(0.001)***		(0.011)**
TB*Basel		1.3372	1.0438		5.2169	-4.9736
		(0.037)**	(0.42)		(0.013)**	(0.231)
Equity	-1.2291	-1.2159	-1.2182	-1.1627	-1.5004	-1.2161
	(0.027)**	(0.028)**	(0.028)**	(0.037)**	(0.020)**	(0.030)**
Revenue growth	0.8359	0.8291	0.8307	0.8464	0.9903	0.8717
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Deposit insurance	-0.0787	-0.08	-0.0771	0.2314	0.1811	0.2321
	(0.835)	(0.833)	(0.839)	(0.562)	(0.701)	(0.561)
Stringency index	-0.0708	-0.0729	-0.0729	-0.1183	-0.1197	-0.1091
	(0.343)	(0.33	(0.33)	(0.125)	(0.176)	(0.157)
Restriction index	-0.1361	-0.136	-0.1363	-0.1673	-0.1483	-0.1664
	(0.003)***	(0.003)***	(0.003)***	(0.000)***	(0.004)***	(0.000)***
GDP growth	0.1313	0.129	0.1293	0.112	0.1279	0.1215
	(0.001)***	(0.002)***	(0.002)***	(0.008)***	(0.007)***	(0.004)***
Inflation	-0.0843	-0.0836	-0.0842	-0.1374	-0.1348	-0.139
	(0.001)***	(0.001)***	(0.001)***	(0.000)***	(0.000)***	(0.000)***
Constant	4.8995	4.9608	4.9488	5.0265	5.5486	4.7925
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Observations	13,908	13,908	13,908	13,895	13,047	13,895
R-squared	0.0051	0.0051	0.0051	Basel	TB*Basel	Basel, TB*Basel
			Instruments:	z-score (national)	TB*z-score(national)	z-score, TB*z-score (national)

p-values in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

This table presents regression results of indicators of bank risk (bank's z-score) on capital regulation (Basel) and other bank-specific and macroeconomic variables. Column 1 to 3 present the results using least square method and column 4 to 6 present the results using instrumental variable (IV) method. The dependent variable is bank's z-score, computed as the bank's return on assets (ROA) plus the capital asset ratio (CAR) divided by the standard deviation of ROA over the period 2003-2007 and 2008-2012. The independent variables that are used are for the year 2004 and 2007 for Basel, equity, revenue growth, GDP growth, inflation and 2001 and 2005 for deposit insurance, stringency, and restriction. The dependent variables are TB is a dummy variable that takes a value of 1 if the bank is a traditional bank and 0 if it shadow bank. Basel is a dummy variable that it takes a value of 1 if the country has implemented Basel and 0 otherwise. TB*Basel is the interaction between TB and Basel. Equity is the ratio of total equity total assets. Revenue growth is the annual growth of total revenues of the banks.

Deposit insurance is a dummy variable that it takes a value of 1 if the country has the explicit deposit insurance and zero otherwise. Stringency index is an index of capital stringency. Restriction index is an index of activity restriction. GDP growth is annual growth of GDP. Inflation is the annual growth of GDP deflator. Z-score is the country's z-score (national level z-score). TB*z-score is the interaction between TB and country z-score.

CHAPTER 4

BANK LEVERAGE AND ASSET POSITIONS: CROSS-COUNTRY EVIDENCE

4.1 Introduction

A number of studies in the economics literature have argued that financial systems are cyclical in nature. In addition to their own cyclical pattern, several studies also conclude that the financial system is pro-cyclical. By this we mean that the financial cyclicality interacts with the overall economy amplifying the business cycle. Adrian and Shin (2014) argue that we can expect lending to be higher during economic expansions and lower during contractions as more projects are needed to be funded in the boom than in the bust. Therefore, pro-cyclicality in this context refers to when the variation of lending is greater than the value of the projects during the expansions and it is lower than the value of the projects during the contractions (Adrian and Shin 2014 and Arjani, 2011).

According to Adrian and Shin (2010) the cyclicality of the banking sector results from how banks manage their leverage in response to different economic conditions. Adrian and Shin (2014) show that banks tend to keep enough equity such that the probability of default is at a constant value, say α. Risk levels vary over the business cycle, therefore in order to keep the probability of failure at α , banks need to expand and contract their balance sheets which implies changing the leverage. Specifically, banks decrease asset exposure when economic conditions become more risky while increasing asset exposure when conditions are less risky.

Adrian and Shin (2010) show that the risk levels, which vary over the business cycle, can be reflected by Value-at-Risk (VaR). In this context, VaR is the approximate worst case loss or the equity capital that the banks must hold in order to stay solvent with

some probability. Over the cycle, banks adjust their balance sheets by changing their capital holding in order to maintain a targeted VaR. To maintain a certain level of VaR, banks reduce their leverage during contractions while raising it in expansions. To examine the pro-cyclicality, Adrian and Shin (2010) regress leverage growth on asset growth. Leverage is pro-cyclical if the coefficient of asset growth is positive. Empirically, Adrian and Shin examine the relationship between asset and leverage growth using the five largest U.S. investment banks. They find that leverage growth is positively correlated with assets growth that is, leverage is pro-cyclical for these investment banks. In contrast, they find the leverage of households and non-financial firms are not pro-cyclical. Laux and Rauter (2014) also find strong pro-cyclicality in the U.S. commercial and saving banks.

The positive relationship between assets and leverage growth implies that leverage is pro-cyclical. During expansion, the demand for banks' asset increases and banks adjust their leverage upward. As Adrian and Shin (2013) have shown, over the business cycle, banks adjust their leverage and treat equity as constant. Therefore, when equity is fixed, variation in leverage is associated with variation in assets. In the upturn, assets increase and banks will increase their leverage. The mechanism works in reverse, in downturns assets decrease and banks engage in deleveraging. Therefore, the relationship between the growth in asset and leverage is positive.

In addition to the banks reacting to the economic circumstances, bank regulation, particularly risk-based capital requirements, have been argued to amplify business cycle fluctuations (Kashyap and Stein, 2004 and Andersen, 2011). The European Banking Authority (EBA) report for 2013 defines a pro-cyclical capital requirement regulation as a

regulation that tends to amplify business cycle fluctuations and causes or exacerbates financial instability.

In general the capital requirement regulations that the financial system regulators impose tend to be pro-cyclical. They require higher capital holdings in bad times and lower capital holdings in good times. Thus, in a recession this so-called risk-based capital standard requires greater capital while the banks' capital position is weak in this state. The higher capital requirements lead banks to reduce their lending (Andersen, 2011) and deleverage during recession. As argued by Adrian and Shin (2010), financial intermediaries' leverage varies over the business cycle while equity is kept fixed. The widespread reduction of lending and deleveraging will aggravate the initial downturn. Conversely, in the upturn the risk-based capital standard leads to lower risk-weighting. Banks have surplus capital during the upturn, which lead banks to lend more and increase their leverage. Therefore, the risk-based capital requirements amplify the cyclicality of the overall economy.

Several studies have examined the impact of Basel accords, an agreement that imposes risk-based capital requirements, on the business cycle. Egert and Sutherland (2012) argue that Basel I leads to banking sector pro-cyclicality because it requires a relatively high (8%) capital adequacy ratio[6]. During the downturn, banks will lend less to meet the requirement. Unlike Basel I, which applies the same capital standard across different types of assets of financial institutions, Basel II specifies the risk to be tied to specific types of assets[7]. Kashyap and Stein (2004) along with Andersen (2011) argue that

[6] A measure of a bank's capital expressed as a percentage of its risk weighted credit exposures.
[7] The first pillar of Basel II sets out the method to calculate minimum regulatory capital. Banks have three options to calculate credit risk. The simplest option is the standardized approach. Under

Basel II tends to strengthen pro-cyclicality based on their theoretical arguments. However, as Egert and Sutherland note this argument has not been tested. The purpose of this study is to empirically examine the effect of Basel II on leverage growth and pro-cyliclicality.

In order to test the hypothesis we collect bank data and the implementation of Basel II from 111 countries. The Basel II implementation data are drawn from Bank for International Settlements (BIS). Our data cover the period of 2004-2011 and coincide with Basel II adoption. From the analysis we should be able to dissent the effect of Basel II on leverage pro-cyclicality.

The results indicate that Basel II increases leverage growth and that leverage is pro-cyclical. We also found that Basel II accords indeed increases the pro-cyclicality. These results conform to the findings suggested by Kashyap and Stein (2004) and Andersen (2011).

The essay is organized as follows. Section 2 provides a literature review on the business cycle and bank leverage. Section 3 explains the data. Section 4 and 5 present the empirical method and results. Section 6 concludes.

4.2 Literature Review

A number of studies have linked the business cycle with bank behavior. Nuno and Thomas (2013) examine the cyclical fluctuation in the U.S. banking industry. They show there exists 'bank leverage cycles' where bank leverage, assets, and GDP move together. The main findings of their studies are i) leverage, equity capital and total assets are more

this approach, assets are grouped according to their risk categories. For example the risk weight of these categories: loans to sovereigns, corporates and banks are determined by the external credit ratings agencies (BIS). Under Basel I each categories carries a fixed risk weighting.

volatile than GDP and ii) leverage is positively correlated to assets and also positively correlated to GDP. Egert and Sutherland (2012) use data from OECD countries, and show that the banking system started to synchronize with the real economic cycle in the 1970s. They conclude that Basel I leads to banking sector pro-cyclicality but they argue that the impact of Basel II is unknown. They found that the leverage ratio is negatively related to lending growth and tier 1 ratio, a measure of capital adequacy, is also negatively related to lending growth. The negative co-movement between lending growth and banks' capital is also observed for different types of banks: commercial, investment, mortgage, saving, and co-operative banks.

One economic indicator that is widely used in relation to banking pro-cyclicality is the supply of credit. Bernanke and Lown (1991) have documented that one of the impacts of Basel I is a reduction in lending. Ivashina and Scarfstein (2010) use the U.S. banking industry and show that all types of lending fell during the financial crisis in 2008. The reduction of lending can be decomposed into demand and supply reductions. The drop of lending is a results of a drop in demand of credit by firms or it may be because of a supply effect; banks that are less capitalized and have riskier credit-lines will cut back their lending by a greater amount in comparison to other banks.

Adrian and Shin (2010) and Adrian and Shin (2013) argue that bank leverage is pro-cyclical. The pro-cyclicality reflects active balance sheet management where leverage is adjusted to the economic environment. When asset prices increase during the expansion period, banks' balance sheets get stronger permitting banks to hold more capital. The excess capital encourages banks to expand their balance sheets. The pro-cyclicality is analyzed using plots of asset and leverage and regressions of leverage on total asset (Adrian

and Shin, 2010). Adrian and Shin (2013) further incorporate the implication of this pro-cyclicality on the supply of credit. Risk varies over the cycle and it is at the highest level during the downturn. To reduce the risk banks withdraw their lending in a recession, thus magnifying the downturn.

In terms of bank capital regulations Andersen (2011) and Arjani (2011) argue that Basel II may increase pro-cyclicality in the banking sector. Basel II, which is basically a risk-based capital requirement, calls for higher capital in periods of recessions when banks' capital is at the lowest level. The higher capital requirement encourages banks to reduce their lending and thus further worsens the recession. The reverse mechanism works during the economic expansion. Basel II requires less capital because risk is lower in the upturn. Banks have excess capital and find a way to employ the excess capital by lending more. Arjani points out several methods that are designated to counter the pro-cyclicality in Basel II. First is to use the Advanced Internal Rating-Based (AIRB) approach to calculate the "loss-given-default at levels likely to prevail during an economic downturn". Under Pillar I of Basel II, there are three options to calculate the credit-risk-weighted value to certain assets, the Standardized approach, the Foundation Internal Rating-Based (FIRB), and the Advanced Internal Rating-Based (AIRB) approach. Second, in order to smooth out default risk estimates over the cycle, it is suggested to use "through-the-cycle" instead of "point-in-time" estimates to calculate the probability of default (PD). The third Basel accords, Basel III incorporates measures to reduce the sensitivity of capital requirements to the business cycle (Repullo and Suarez, 2013).

Repullo (2013) highlights the trade-off that takes place concerning the risk-based capital requirements. On the one hand, when the economy is contracting, Basel II requires

more capital and hence leads to a reduction in lending and worsens the recession. On the other, if we want to lessen the impact of the crisis by lowering the capital requirements, banks will assume greater risks. Thus, by setting higher capital requirements, the social cost of bank failure is lower but this will decrease aggregate investment and lending. Repullo (2013) shows formally that risk-based capital requirements need to be adjusted to reduce its pro-cyclicality. The capital requirement should be lowered when bank capital is limited. Using the model, Repullo shows that a negative shock to aggregate supply of bank capital should be accompanied by a reduction in the capital requirement. If the level of capital requirement is maintained banks will be safer but it will lead to a disproportionate reduction in economic activities. Therefore, it is optimal to lower the capital requirement when the economy is in recession.

Repullo and Suarez (2013) also examine the impacts of capital requirements on credit supply. However instead of looking at a negative shock of capital as an indicator of the state of the economy, their paper focuses on ease with which banks can access equity market. They show that if banks cannot access the capital market freely then there will be variation in the supply of credit. This variation is larger under Basel II. The paper compares the welfare under no capital requirements, Basel I, Basel II, and capital requirements that maximizes the welfare. The results show that Basel II results in a more pro-cyclical banking sector but it also reduces the probability of bank failure in recession and it has higher welfare.

Risk-based capital standards, such as Basel I and Basel II, are believed to increase the pro-cyclicality of the financial system according to theoretical models. While both Basel accords are pro-cyclical, previous theoretical studies have placed more emphasized

on examining the pro-cyclicality of Basel II. A paper that compares the pro-cyclicality between Basel I and Basel II is Angelini et al. (2010). They examine to what degree pro-cyclicality introduced by Basel II exceed that of Basel I and they found that the extra pro-cyclicality due to Basel II is relatively small in their theoretical paper.

One important feature of bank capital is that most banks have a capital level that is higher than the regulatory minimum. Some argue that this excess capital may dampen or eliminate the pro-cyclicality of capital regulation on the lending pattern (Angelini, 2010). However, Repullo and Suarez (2013) show formally that the equilibrium of the excess capital is not sufficient to mitigate the impact of a recession on lending.

Although there are ample theoretical studies on pro-cyclicality, there are only a few empirical studies in this area. In line with the previous literature outlined in the first two sections, this paper examines the impact of Basel II on banking sector leverage using cross-country data from 2005-2011.

4.3 Data

This study uses the assets and equity annual data from 2005-2011 at the individual bank level. The individual bank data are drawn from Orbis database published by Bureau van Dijk (BvD). Total assets and equity are collected from the database. Asset growth is constructed by taking the log difference of assets between two periods. Leverage is defined as the ratio of total asset to equity (Adrian and Shin, 2010).

In addition to the bank-level data, we include several country-level variables in the regression. These variables are Basel II, GDP growth, and market liquidity. Basel II is included to answer the question whether risk-based capital regulation affects leverage growth. We include GDP growth and some measure of market liquidity when estimating pro-cyclicality following Damar et.al (2013). Data for Basel II implementation are drawn

from the Financial Stability Institute (FSI) survey and Bank Regulation and Supervision Survey (BRSS). The FSI survey and BRSS are conducted by the Bank for International Settlements (BIS) and the World Bank respectively. The FSI July 2012 report contains implementation dates of Basel II, 2.5 and III[8] for 131 countries. Some missing data are supplemented from the BRSS. In the regressions Basel is a dummy variable, which takes on the value 1 if a country has implemented Basel II by a certain year and 0 otherwise.

Higher GDP growth rate will result in stronger pro-cyclicality as it reduces the cost of rolling over short-term debt and therefore increases leverage growth (Damar et al, 2013). GDP real growth data are obtained from the World Bank. Damar et al (2013) also argue that if the market is more liquid it is easier for banks to adjust their leverage. Their empirical findings confirm the positive association between leverage and liquidity. As a measure of market liquidity, we use the ratio of liquid assets to deposit and short term funding. The data are obtained from Global Financial Development Database (GFDD) 2013 from the World Bank. Based on their definition, liquid assets include cash and due[9] from banks, trading securities and at fair value through income, loans and advances to banks, reverse repos and cash collaterals. Deposits and short term funding includes total customer deposits (current, savings and term[10]) and short term borrowing (money market instruments, CDs and other deposits).

[8] This study focuses on Basel II since we do not have the complete data on the implementation of Basel 2.5 and III. Basel 2.5 was agreed in 2009 and was due to be implemented in 2011. Basel III was introduced in 2010 and scheduled to be implemented in 2013 up through 2019.

[9] Due from banks represents receivables from, or short-term loans to, other banks or financial institutions.

[10] Term deposit or time deposit is a deposit held at financial institutions over a fixed period of time.

In line with the first essay, traditional and shadow banks are identified according to the standard industrial classification (SIC) following Acharya et al. (2010). The classification is based on the Office of Occupational Safety & Health Administration (OSHA). OSHA categorizes finance, insurance, real estate under division H which is identified as code 6000 through 6799. This broad division is divided into seven categories; depository institutions (code 6011-6099), non-depository credit institutions (code 6111-6163), Security and Commodity Brokers, Dealers, Exchanges, and Service (code 6211-6289), Insurance Carriers (code 6311-6399), Insurance Agents, Brokers, and Service (6411), Real Estate (code 6512-6553), Holding and Other Investment Offices (code 6712-6799) (www.osha.gov). Based on the approach used by Adrian and Shin (2010) I define shadow banks as those entities that fall under the category of non-depository credit institutions (code 6111-6163), whereas I define the traditional banks to consist of depository institutions (code 6011-6099).

Table 1 present some summary statistics for the entire sample of banks along with country level data. There are total of 102,933 bank observations from 112 countries, which cover the period from 2005 to 2011. The average of leverage growth and asset growth are negative in our dataset. Table 1 combines both traditional and shadow bank observations. TB is a dummy variable which takes on the value of 1 if the observation refers to a traditional bank and 0 otherwise. The average of TB is 0.92, which implies that 92 percent or 108,034 are traditional banks and the rest or 9,161 observations are shadow banks.

The country level data that are presented in Table 3 are for the year 2005 and 2011. In 2011 there are 111 countries in the dataset while in 2004 112 countries. GDP growth fluctuates over the period of 2005 to 2011 and it reaches the lowest point in 2009 during the financial

crisis. Liquidity seems relatively stable over this period. In 2004 only one country had implemented Basel II and by 2011 more than half of the countries in the dataset had implemented it.

4.4 Empirical Model

There are two analyses in this essay. First, we examine the leverage pro-cyclicality and second, we assess the effect of Basel using difference-in-difference approach. The empirical model to estimate leverage pro-cyclicality is based on Adrian and Shin (2010), Damar et al (2013), Card and Krueger (1994), and Card (1992). Adrian and Shin (2010) regress leverage growth on asset growth to examine the pro-cyclicality in leverage. A positive coefficient on asset growth indicates that leverage is pro-cyclical. Their model only include bank-level data. Damar et al. (2013) incorporate both bank and country-level data. We include both individual and country-level variable in our empirical models following Damar et al. (2013).

To obtain the difference-in-differences effect of Basel II on leverage pro-cyclicality we follow the modeling strategy of Card and Krueger (1994) and Card (1992). Card and Krueger (1994) examine the effect of an increase in minimum wage on employment in fast food restaurants. The minimum wage was raised in New Jersey on April 1992. They collect the data on employment for two periods, before and after the minimum wage change, in two states, New Jersey and Pennsylvania. Pennsylvania did not increase the minimum wage. Therefore, New Jersey serves as the treatment state and Pennsylvania as the control state. They calculate a simple difference-in-difference using average employment and since they only have two periods they fit the following regression.

$$\Delta E_i = a + b\,\boldsymbol{X_i} + c\,NJ_i + \varepsilon_i \quad (1)$$

where ΔE_i is the change in employment between the two periods, $\boldsymbol{X_i}$ is a set characteristics of restaurant I, and NJ_i is a dummy variable and it equals 1 if the restaurant is in New Jersey. The difference-in-differences can be estimated using regression (Angrist and Pischke, 2009):

$$E_{ist} = \alpha + \gamma NJ_s + \lambda d_t + \delta(NJ_s * d_t) + \varepsilon_{ist} \quad (2)$$

where E_{ist} is the employment at restaurant i in state s at time t. NJ_s is a dummy variable and it equals 1 if the restaurant is in New Jersey. d_t is the time dummy, it equals 1 for observations after the minimum wage change. The difference-in-difference is represented by δ. Card (1992) shows that additional explanatory variables can be added into the regression model (2) such as

$$E_{ist} = \alpha + \gamma NJ_s + \lambda d_t + \delta(NJ_s * d_t) + X'_{ist}\,\beta + \varepsilon_{ist} \quad (3)$$

where X_{ist} is the additional covariates for example individual characteristics of the workers or state-level explanatory variables.

Instead of comparing two states as in Card and Krueger (1995), this study compares two banking sectors, traditional and shadow. We also have the information before and after Basel II implementation, for instance in 2011 almost 60 percent of countries in the sample have implemented Basel II. Basel II is only applicable for the traditional banking sector, therefore traditional banking sector will be the treatment and shadow banking sector is the control. Then we can apply the difference-in-difference approach to evaluate the effect of Basel on banking sector leverage.

The first model only includes a dummy indicating the banking sector and a dummy for Basel implementation similar to equation 2.

$$Leverage\ Growth_{ist} = \alpha + \gamma TB_s + \lambda Basel_t + \delta(TB_s * Basel_t) + \varepsilon_{ist} \quad (4)$$

where leverage growth is the log difference in leverage at bank i in sector s and period t. Leverage is the ratio of total assets to equity. TB is a dummy variable for traditional banks, which takes the value of 1 if traditional banks and 0 if shadow banks. Basel is a dummy variable of Basel II implementation, it takes the value of 1 if a country has implemented Basel II by a certain year and 0 otherwise. The estimator of δ is labeled as the difference-in-differences (DD) estimator, in this case δ is DD estimates of the effects of traditional banks that implemented Basel II.

The second model includes asset growth to examine the pro-cyclicality along with several country-level variables as the additional covariates in the spirit of equation 3.

$$Leverage\ Growth_{ist} = \alpha + \gamma TB_s + \lambda Basel_t + \delta(TB_s * Basel_t) + \beta_1\, Asset\ Growth_{ist} + \beta_2 Ln(Leverage)_{ist-2} + \beta_3\, Market\ Liquidity_{st} + \beta_4\, GDP\ Growth_{st} + \varepsilon_{ist} \quad (5)$$

where leverage growth is log difference in leverage of bank i in sector s and period t and leverage is the ratio of total assets to equity. Asset growth is log difference in assets at bank i in sector s and period t, market liquidity is the ratio of liquid assets to deposit and short term funding in sector s and period t, and GDP growth is annual growth of GDP in sector s at time t.

The last model includes all interaction terms of asset growth, Basel, TB allowing change in intercept and slope in estimating leverage pro-cyclicality. Following Adrian and Shin (2010), coefficients of asset growth are the main interest, the larger the coefficient the more pro-cyclical is leverage. To avoid bias estimates we use $\ln(\text{leverage})_{t-2}$ instead of $\ln(\text{Leverage})_{t-1}$ since the left hand side variable is log difference in leverage.

$$Leverage\ Growth_{ist} = \alpha + \gamma TB_s + \lambda Basel_t + \delta(TB_s * Basel_t)$$
$$+\beta_1\ Asset\ Growth_{ist} + \beta_2\ Basel_t * Asset\ Growth_{ist}$$
$$+ \beta_3\ TB_{it} * Asset\ Growth_{ist} + \beta_4 TB_s * Basel_t$$
$$+ \beta_5 TB_s * Basel_t * Asset\ Growth_{ist} + \beta_6 Ln(Leverage)_{ist-2}$$
$$+ \beta_7\ Market\ Liquidity_{st} + \beta_8\ GDP\ Growth_{st} + \varepsilon_{ist} \qquad (6)$$

Using the estimation results from this equation we can compare the pro-cyclicality of traditional and shadow banking (first row of Table 2). We also are able to see if Basel II strengthens the pro-cyclicality in traditional banking sector (first column of Table 2). The next section presents a discussion of some regression results using the empirical models.

4.5 Results

Table 3 present the regression results. The numbers in the parentheses are P-values. The least square method is used to estimate equation 4, 5, and 6. Country and year dummies are included in every regression except for the cross-section regressions, which only include country dummies (Table 5). The dependent variables in all of the regressions are leverage growth. We test Basel with all its interaction terms, TB and all its interaction terms, and asset growth and all its interaction terms. The F-tests are all significant at least at 5% level except for Basel and TB*Basel in column 2 of Table 3, which is only marginally significant at the 10% level. Column 1 of Table 3 presents the estimation results using equation 4. The column shows that only Basel coefficient is significant at 5% level. Basel is a dummy variable, therefore it is interpreted as the differential effect of Basel between banks in countries that implement Basel and banks in countries that do not implement Basel. This coefficient suggests that banks in countries that have implemented Basel are

associated with higher leverage growth of 1.7 percentage points relative to those in non-Basel country.

Column 2 of Table 3 presents the results from estimating equation 5. It includes asset growth and country-level variables. All coefficients are significant except Basel and GDP growth. The DD estimate, i.e. the interaction between Basel and TB, is significant at 10% level. The DD estimate reflects the differential effects of Basel on leverage growth in traditional banks relative to shadow banks. The DD estimate suggests that Basel increases leverage growth by 1.0468 percentage points for traditional banks relative to shadow banks. The coefficient of asset growth is positive, suggesting that leverage is pro-cyclical. A percent increase in asset growth is associated with 0.407 percent increase in leverage growth. In contrast to Adrian and Shin's (2010) findings, we find that the lag of the logarithm of leverage is positive. An increase in lagged leverage of one percent, on average, leads to about 8.381 percent increase in leverage growth. Market liquidity, which is measured as the ratio of liquid assets to deposit and short term funding, has a positive effect on leverage growth as expected. Higher market liquidity makes it easier for bank to leverage up. On average, one percent increase in market liquidity leads to 0.0716 percent increase in leverage growth.

The last column (column 3) of Table 3 shows the results from estimating equation 6. In this column all interaction terms of asset growth, Basel, and TB are included. The DD estimate is positive and significant similar to the previous results. The coefficient suggests that the effect of Basel II is 2.798 percentage point higher in traditional banks relative to the shadow banks. These results allows us to compare the pro-cyclicality of traditional and shadow banks and the effect of Basel on traditional banks. We are unable to examine the

direct effect of Basel on shadow banks because only traditional banks are subject to Basel II accord. Table 4 summarizes the comparisons.

In Table 4, TB=1 indicates traditional banks and TB=0 indicates shadow bank, B=1 indicates banks in countries that have implemented Basel II and B=0 refer to banks in countries that have not implemented Basel II. From the second row of Table 4 we can compare the coefficients of asset growth for traditional banks (0.3542) and for shadow banks (0.5085). The coefficients of asset growth are positive suggesting that leverage is pro-cyclical in the two banking sectors. However, the coefficient of asset for shadow banks is 15.4 percentage points higher than for traditional banks and thus shadow banks are more pro-cyclical. Column 1 of Table 4 allows us to compare leverage pro-cyclicality for traditional banks that implement and those that do not implement Basel II. The coefficient of asset growth is 0.4627 for traditional banks that implement Basel II and it is 0.3542 for traditional banks that do not implement Basel II. These results suggest that traditional banks that implement Basel II have a higher asset growth coefficient of 10.85 percentage points and therefore Basel II induces more pro-cyclicality for traditional banks. This result is in line with the findings in Kashyap and Stein (2004), Andersen (2011) and Egert and Sutherland (2012). This findings suggest that there is room for improving the capital regulation under the Basel Accord. One option is to modify the risk-weight as suggested by Repullo (2013), the capital requirement should be reduced during downturn and raised in the upturn.

Table 5 presents the regression results using cross-section data. This regression is motivated by the economic growth literature, in which GDP growth is determined by the initial condition (initial value of GDP or capital) and other explanatory variables (Barro

and Sala-i-Martin, 1995). In our case, leverage growth is dependent of the initial value of leverage, instead of lagged leverage as in the previous results (Table 3), and other control variables including assets. The dependent variable is the average of leverage growth from 2005 to 2011. All of the independent variables are also averages over the same period and the initial value of leverage is leverage in 2004. Column 1 of Table 5 displays the regression result with TB and asset growth as the independent variable while column 2 includes the initial value of leverage and macroeconomic variables in addition to TB and asset growth. The results indicate that asset growth is positive in both regressions suggesting that leverage is pro-cyclical. In this specification, GDP growth and liquidity are not statistically different from zero while the initial level of leverage is positive and significant. This result implies that banks with a higher level of leverage, have faster leverage growth. Therefore, we find no evidence of absolute leverage convergence between low-level leveraged and high-level leveraged banks.

4.6 Conclusions

The purpose of this study is to examine the effect of Basel II implementation on banks' leverage growth. The analysis also allows us to calculate the difference-in-difference effect of Basel. Traditional banks serve as the treatment group since Basel II is only applied to this group and shadow banks serve as the control group. The results show that Basel II increases banks' leverage growth.

We have presented empirical evidence regarding leverage pro-cyclicality in relation to implementation of Basel II for traditional and shadow banks using cross country data. The results show that leverage is pro-cyclical across countries and in both banking sectors. We examine further the level of pro-cyclicality for those sectors and found that the

level of pro-cyclicality is higher in the shadow banking than in traditional banking sector. These findings suggest that shadow banks are more active in managing their balance sheets. They are more reactive to changing economic condition and adjust their balance sheets accordingly.

Implementation of Basel II intensifies leverage pro-cyclicality in the traditional banking sector. This stems from the fact that Basel II is a risk-weighted capital standard. It requires more capital when economic conditions are poorer, exactly when bank capital level is generally at the lowest point and this behavior exacerbates the downturn. This mechanism works in the opposite direction too. Basel II requires less capital in good times when banks have surplus capital. Therefore, banks find a way to employ the excess capital, for instance, by lending more, which in turn strengthens the boom. One way to reduce the pro-cyclicality is by adjusting the risk-weight capital requirement so that it requires less in the recessions and requires more in the boom.

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Table 4.1: Summary Statistics

Variable	Unit	No. of observation	Mean	Std. Dev.	Min	Max
	(1)	(2)	(4)	(5)	(6)	(7)
Bank level						
Leverage growth		102,933	-0.004	0.24	-7.85	7.51
Asset growth		102,933	-0.08	0.24	-11.80	7.71
$Ln(Leverage)_{-2}$		102,933	2.28	0.65	-0.32	10.48
Dummy traditional bank (TB)		102,933	0.28	0.27	0	1
Country level						
Basel 2005		113	0.56	0.50	0	1
Basel 2011		113	0.54	0.50	0	1
GDP growth 2005	Percent	111	5.20	3.00	-0.18	18.26
GDP growth 2011	Percent	111	3.89	3.50	-10.48	15.00
Ratio of the liquid assets to short- term funding and total deposit 2005	Percent	111	36.33	17.37	1.62	81.02
Ratio of the liquid assets to short- term funding and total deposit 2011	Percent	111	33.16	20.07	6.68	133.78

This table presents summary statistics of variables that are used in the analysis. Leverage is the ratio of total asset to equity and leverage growth is the annual growth of leverage. TB is a dummy variable that takes a value of 1 if the bank is a traditional bank and 0 if it shadow bank. Basel is a dummy variable that it takes a value of 1 if the country has implemented Basel and 0 otherwise. Liquidity is the ratio of liquid assets to deposit and short term funding. GDP growth is annual growth of GDP.

Table 4.2: Leverage Pro-cyclicality

	TB=1	**TB=0**
Coefficient of asset growth when B=1	$\beta_1 + \beta_2 + \beta_3 + \beta_5$	n.a.*
Coefficient of asset growth when B=0	$\beta_1 + \beta_3$	β_1

*Note: Basel II is not applied for shadow banks

Table 4.3: Regression Results of Leverage Growth on Asset Growth

Method: Least squares

	1	2	3
	Leverage Growth	**Leverage Growth**	**Leverage Growth**
TB	-0.5587	-1.617	-3.3655
	(0.135)	(0.000)***	(0.000)***
Basel	1.7035	-0.7384	-1.7002
	(0.027)**	(0.293)	(0.016)**
TB*Basel	0.0737	1.0468	2.7982
	(0.908)	(0.068)*	(0.000)***
Asset growth		0.407	0.5085
		(0.000)***	(0.000)***
Asset growth* Basel			-0.0475
			(0.001)***
TB*Asset growth			-0.1543
			(0.000)***
TB*Basel*Asset growth			0.156
			(0.000)***
$Ln(Leverage)_{-2}$		5.3814	5.3957
		(0.000)***	(0.000)***
Liquidity		0.0716	0.0694
		(0.000)***	(0.000)***
GDP growth		0.0723	0.0376
		(0.141)	(0.443)
Constant	2.4243	-6.0376	-5.4241
	(0.729)	(0.341)	(0.391)
Observations	102,933	102,933	102,933
Adjusted R-squared	0.01	0.19	0.19
Country dummy	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes

p values in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

This table presents regression results of leverage growth on capital regulation (Basel), assets, and other bank-specific and macroeconomic variables. Leverage growth and asset growth are in percent. The dependent variable is leverage growth 2005 to 2011. The independent variables that are used are for the year 2005 and 2011. Leverage is the ratio of total asset to equity and leverage growth is the annual growth of leverage. TB is a dummy variable that takes a value of 1 if the bank is a traditional bank and 0 if it shadow bank. Basel is a dummy variable that it takes a value of 1 if the country has implemented Basel and 0 otherwise. Liquidity is the ratio of liquid assets to deposit and short term funding. GDP growth is annual growth of GDP.

Table 4.4: Leverage Pro-cyclicality: Results

	(1) **TB=1**	(2) **TB=0**	
(1) Coefficient of asset growth when **B=1**	**0.4627**	n.a.*	
(2) Coefficient of asset growth when **B=0**	**0.3542**	**0.5085**	Shadow banks are more pro-cyclical
	Basel II leads to more pro-cyclicality		

*Note: Basel II is not applied to shadow banks

Table 4.5: Regression Results of Leverage Growth on Asset Growth: Average

Method: Least squares

	1 **Leverage Growth (average 2005-2011)**	2 **Leverage Growth (average 2005-2011)**
TB	0.3716	-0.6987
	-0.301	(0.046)**
Asset growth	0.4336	0.4124
	(0.000)***	(0.000)***
Initial Ln(Leverage)		4.4381
		(0.000)***
Liquidity		0.0078
		(0.885)
GDP growth		0.5723
		(0.144)
Constant	8.0682	-5.5006
	-0.175	(0.413)
Observations	15,087	15,087
Adjusted R-squared	0.28	0.32
Country dummy	Yes	Yes

p values in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

This table presents regression results of leverage growth on capital regulation (Basel), assets, and other bank-specific and macroeconomic variables. Leverage growth and asset growth are in percent. The dependent variable is the average of leverage growth from 2005 to 2011. The independent variables that are used are the average from 2005 to 2011. Leverage is the ratio of total asset to equity and leverage growth is the annual growth of leverage. Initial leverage is leverage for the year 2004. TB is a dummy variable that takes a value of 1 if the bank is a traditional bank and 0 if it shadow bank. Basel is a dummy variable that it takes a value of 1 if the country has implemented Basel and 0 otherwise. Liquidity is the ratio of liquid assets to deposit and short term funding. GDP growth is annual growth of GDP.

CHAPTER 5

CONCLUSIONS AND POLICY IMPLICATIONS

Financial stability has been one of the main targets of central banks. At the international level, the Basel Committee on Banking Supervision (BCBS) shares this same goal. As the standard setter for banking regulations, it has attempted to standardize capital regulations globally to minimize the worldwide effects of financial disruptions. The intention of the capital regulations proposed by the committee is to restrict banks from taking excessive risks and to provide cushions to absorb losses in the event of negative shocks adversely impacting a country's banking system. It is then natural to ask: is capital regulation effective in accomplishing its objectives?

The focus of this dissertation was to analyze the effectiveness of capital regulations in relation to traditional and shadow banking entities. The shadow banking sector rose in important in the past several decades. It grew rapidly and in some countries this sector has surpassed the traditional sector in term of volumes of activities, possibly leading or contributing to the 2007 financial crisis, as has been suggested by several studies. Thus, better understanding of the shadow banking sector and its interactions with the traditional banking sector will help us understand how to improve the system in order to obtain overall financial sector stability. This dissertation, thus, examines how capital regulations influence the relative size of shadow banking sector, the risk-taking behavior of the two sectors, and how they influence the cyclicality of those sectors.

The first essay analyses how minimum capital requirements affect the shadow banking sector. The share of shadow to total traditional and shadow banking assets is used

to measure shadow banking growth. Previous literature has argued that increased regulation of the traditional banking sector will lead to regulatory arbitrage and increase in shadow banking activities. The shadow banking sector is relatively less regulated than its traditional counterpart. The restrictions in the traditional banking sector will encourage banks to shift their operation away to the shadow banking sector. This hypothesis is tested using data from 76 countries over the 2005 through 2010 period. Hausman-Taylor approach is utilized to analyze the impact of minimum capital requirements on the share of shadow banking assets. This approach is appropriate because it can accommodate corrections for the endogeneity of the minimum capital requirements and it allows us to account for the effect of time-invariant covariates. The results provide some evidence in favor of the regulatory arbitrage hypothesis, particularly in high-income countries.

The result is as expected, minimum capital requirements increase the share of shadow banking activities in the high-income countries. More advanced economies tend to have larger shadow banking sector, which may be because the sector requires more complex financial systems and better technology to develop. Therefore, minimum capital requirements have bigger impacts in advanced economies, increasing shadow banking activities in these countries. The policy implication of this finding is apparent, capital regulations should not be made uniform and inflexible. To be effective the regulation should accommodate variations in countries' characteristics.

The second essay analyzes bank risk-taking behavior when the capital requirement is strengthened. Two risk measures are used, the share of non-performing loans to total loans in the bank's portfolio as a measure of ex-post risk and bank z-score as a measure of ex-ante risk. This essay is motivated by the diverse arguments on the effectiveness of

capital regulations. Those regulations are proxied by implementation of Basel II, with its intent to reduce risks. The sample contains data from 82 countries over the 2005 through 2012 period. Basel II may be endogenous, therefore an instrumental variable approach is used to assess risk-taking behavior. The instrument for Basel II is a country's z-score or the probability of default of a country's banking system. The results show that Basel II is effective in reducing both ex-post and ex-ante risks. The shadow banking sector is found to take on higher ex-ante risk while the traditional banking sector tend to take on higher ex-post risks. Thus, the findings support the argument that Basel II limits bank risk-taking behavior.

The third essay assesses the level of pro-cyclicality of traditional and shadow banking sectors using the relationship between leverage and assets. It further considers the effect of Basel II implementation on leverage growth. It has been argued that Basel II, which is a risk-weighted capital regulation, is pro-cyclical. It requires more capital when the economy is in recession, which then leads to lower lending, which aggravates the downturn. By the same mechanism, it intensifies the upturn. Pro-cyclicality is observed by measuring a positive relationship between asset growth and leverage growth. The implication of pro-cyclicality is that it exacerbates overall economic fluctuations. The sample of 111 countries are pooled over the period of 2005-2011. The results indicate that the traditional banking sector tends to be less pro-cyclical than the shadow banking sector. Basel II implementation is found to intensify the pro-cyclicality in both sectors. This essay leaves the discussion on how to reduce pro-cyclicality, especially in the shadow banking sector is an important topic that will need to be tacked in the future.

This dissertation sheds some light on the effects of capital regulations imposed on the traditional and shadow banking sector. The results from the second and third essay indicate that capital regulation is effective in reducing bank-risk taking, however it leads to more pro-cyclicality. Despite its effectiveness, capital regulations also brings unintended consequences by worsening the business cycle. Thus, we may need other mechanisms or regulations to deal with the pro-cyclicality that capital regulations impart on the banking sector.