Fighting complexity with simplicity

The impact of a minimum leverage ratio requirement on bank stability

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"There is no practice more dangerous than that of borrowing money."

George Washington to Sam Washington, 1797

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Abstract

Research on the impact of already imposed minimum leverage ratio requirements on bank stability is, in contrast with the potential impact of Basel III's leverage ratio on bank stability, a topic that is less explored. Main objective of this thesis is therefore to assess the impact of minimum leverage ratio requirements already in place on the stability in those respective banking-sectors. In order to do so, provide the United States and Canada an excellent benchmark. Other determinants of bank stability and the relationship between capitalization and bank stability will in addition be tested. This will be done by conducting an empirical research combining datasets on bank stability and regulations covering a sample of 11.183 banks from the United States, Canada and the European Union, observed over the period 2003-2013. The empirical evidence brings forward inconclusive results concerning the (regulatory) bank capital-stability relationship. The results furthermore reveal that the leverage ratio's benefit to bank stability primarily comes from an increase in the quality of credit in the portfolio of banks. There is in addition provided evidence that other aspects, e.g. the stringency of capital requirements and bank capitalization, furthermore have a significant effect on the capital-stability relationship. The results therefore indicate that no regulatory measure can be evaluated in isolation, as simplicity is only a small proportion of complexity. The overarching message of this thesis is therefore that a minimum leverage ratio requirement can potentially provide benefits to the stability of banks, although it merely is one variable part of a complex equation.

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List of Abbreviations

BCBS	Basel Committee on Banking Supervision
BIS	Bank for International Settlements
CDO	Collateralized debt obligation
CEPS	Centre for European Policy Studies
CRA	Credit rating agency
EBA	European Banking Authority
FDIC	Federal Deposit Insurance Corporation
FED	Federal Reserve System
FSF	Financial Stability Forum
G-10	Group of Ten
G-20	Group of Twenty
GAAP	Generally accepted accounting principles
GDP	Gross domestic product
GFMA	Global Financial Markets Association
IFRS	International financial reporting standards
IMF	International Monetary Fund
LR	Leverage ratio
OBS	Off-balance sheet
OECD	Organization for Economic Co-operation and Development
OSFI	Office of the Superintendent of Financial Institutions
ROA	Return on assets
RWA	Risk-weighted assets
TBTF	Too-big-to-fail
US	United States

1. Introduction

It seems paradoxical that an industry that depends so heavily on trust is additionally one of the most regulated industries. The financial crisis however provided, yet again, rationale for why sound regulation is essential to the stability of the financial sector. Specifically, it became clear during the past decade that bankers all over the world were able to obtain massive gains at loss of others (Herring, 2010). The recent financial turmoil furthermore made clear that financial institutions worldwide entered the crisis with excessive leverage, leaving them more vulnerable to shocks and instability (see e.g. Hildebrand, 2008). As credit is the root of credo, i.e. Latin for "I believe", the recent credit crisis can as well be interpreted as a crisis of trust. This crisis of trust thereafter led to severe spillovers to the real economy; therefore make banking stability, especially as the financial sector is becoming increasingly interconnected, important. Notwithstanding the fact that there is still no consensus on if and how banks should be regulated, regulation is generally justified by the importance of preserving such financial stability (Santos, 2000). Following definitions by the European Central Bank (2011), financial stability is hereinafter defined as "a condition in which the financial system –which comprises financial intermediaries, markets and market infrastructures– is capable of withstanding shocks and the unraveling of financial imbalances. This mitigates the likelihood of disruptions in the financial intermediation process that are severe enough to significantly impair the allocation of savings to profitable investment opportunities." Financial stability is largely affected by the amount of capital that banks hold, as it provides financial institutions with a buffer to withstand shocks (Dewatripont & Tirole, 1994), thereby providing rationale for why rules on bank capital are at the core of banking regulation. Nonetheless have capital ratios of banks fallen significantly over the past decades, e.g. in case of the United States equity constituted around fifty percent of assets in 1840 while nowadays a leverage ratio of five percent is imposed (Berger, Herring, & Szegö, 1995). Whether banks should be subject to an un-weighted capital measure, such as the leverage ratio, is currently being debated. Although some countries, e.g. the United States and Canada, already impose such risk un-weighted minimum capital requirement there is offered, particularly by European countries, an

enormous amount of resistance against implementing it internationally. Notwithstanding the fact that regulators still predominantly measure risk by risk-weighted assets, there is increasing political support for implementing an un-weighted risk measurement in conjunction with the current risk-weighted regulatory capital requirements. This increasing support is motivated by the fact that it is not assured that the risk-weighted capital ratio is superior to the leverage ratio in capturing the overall risk of banks (Estrella, Park, & Peristiani, 2002). Nevertheless is research on the impact of a leverage ratio requirement on bank stability inconclusive and often contradicting. More specifically can views on a minimum leverage ratio requirement be broadly divided into three classes: ones which claim that a leverage ratio is superior to the current regulatory framework of risk-weighted assets, ones which claim that a leverage ratio is a credible supplement to the current regulatory framework of risk-weighted assets and ones which claim that a leverage ratio would in effect would harm bank stability. Positive attributes are merely centered on the ability of the leverage ratio to limit regulatory arbitrage as well as excessive leverage undertaking (see e.g. Basel Committee on Banking Supervision, 2014; Atkinson & Blundell-Wignall, 2010). A leverage ratio requirement could however, as shown by Kiema and Jokivuolle (2014), in addition incentivize banks to increase risk, which in effect would harm bank stability. Notwithstanding the previously mentioned possible negative implications for bank stability, there is a large group of policy makers and researchers who claim that the leverage ratio is the cause of the strong recovery of the banking sector of the United States and Canada (see e.g. Bordeleau, Crawford, & Graham, 2009; Herring, 2010). As these countries already impose a minimum leverage ratio requirement they provide an excellent benchmark to assess whether such capital requirement rightfully enhances bank stability.

The remainder of this thesis is structured as follows. In section 2 will an overview of the current state of literature in the field of bank regulation, capital and stability be provided. This part will furthermore cover the development of the hypotheses. Thereafter is, in section 3, the construction and design of the sample described. In section 4 is a detailed description of the empirical methods employed provided and furthermore is the regression analysis described. Section

5 thereafter presents the empirical results of the analyses as constructed in section 4. Finally are, in section 6, the conclusion and limitations of this thesis documented. In addition are recommendations for further research presented in this chapter.

2. Literature review and hypotheses development

In this chapter, the first section part will cover the regulatory environment. In the subsequent section will an overview of the existing literature on the relationship between capital and stability be given. Afterwards in section 2.3 is the leverage ratio explored to a greater extent. Lastly will the main hypotheses of this thesis be developed in section 2.4.

Capitalism is the astounding belief that the wickedest of men will do the wickedest of things for the greatest good of everyone, John Maynard Keynes.

Unfortunately seems this optimistic belief in the virtue of man unrealistic and does not hold in the real world. Banking is definitely one of the most regulated industries in the world, and this is a direct result from the central role that banks play in financial intermediation and the importance of bank capital for bank as well as economic resilience (Santos, 2000). Banks have always been the most important financial intermediaries in basically all economies, especially since their evolution in the 18^{th} century. The important services financial intermediaries provide make them worth of receiving special regulatory attention and the negative externalities when something goes wrong in the financial sector make a case for regulation. Especially as the banking sector is becoming more and more interconnected and spillovers are becoming more easily transmitted, thereby making sound regulation increasingly important.

2.1 The regulatory environment

There are important features to the regulatory policy, but its primary role is to ensure soundness of the financial sector and it has to do so by lowering the probability of bank failure and lower social cost when such failure should occur (Basel Committee on Banking Supervision, 2012). Although there is no consensus on if and how banks should be regulated, there is growing evidence

that sound regulation benefits banking stability. In this thesis focus is on the impact of one aspect of banking regulation, i.e. regulatory capital requirements, on bank stability. Although researchers have come to contradicting views on the impact of risk un-weighted capital requirements on bank stability, there is consensus on that capital promotes banking stability to a greater extent when capital regulation is more stringent (Barth, Caprio, & Levine, 2006; Brewer, Kaufman,& Wall, 2008). There are, in addition to capital requirements, other features of regulatory policy that additionally contribute to bank stability. For example Barth et al. (2001) find that a regulatory framework that "forces accurate information disclosure, legitimizes private sector monitoring of banks, and incentivizes private agents to exert corporate control" has a positive effect on bank stability as well. As banks are subject to regulation based on a federal as well as multilateral law, the forthcoming part will elaborate on the regulatory environment to provide some context to the jurisdiction in which banks nowadays operate. In an international setting arose the need for a communal capital framework after a period of deregulation and increased international presence of banks, and the establishment of the Basel Committee on Banking Supervision by the G-10[1] in 1974 paved the way for international cooperation on such framework (BCBS, 2013). Its objective was to enhance financial stability by improving supervisory knowhow and the quality of banking supervision (BCBS, 2013). Apart of other aspects of the regulatory framework, try regulators to enhance such financial stability by imposing minimum capital requirements on banks, which regulators consider as the main tool for preventing banks to take excessive risk due to the belief that a structure that provides banks the flexibility to determine their risk-appetite themselves is more effective than structural controls (Cannata & Quagliariello, 2009). This belief subsequently resulted in a broad consensus on the risk-weighted measurement of risk, although the risk un-weighted leverage ratio is additionally introduced in the most recent Basel agreements. Although the Basel regulatory framework provides guidelines on

[1] The Group of Ten (G-10) is a consortium of industrialized countries that co-operate and debate on international financial matters. The consortium is composed of Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, United Kingdom and the United States.

minimum capital requirements, it is up to every country to set requirements high enough to secure a stable financial sector. Or as the G-20[2] puts it, "regulation is first and foremost the responsibility of national regulators". [3] Concerning countries within the scope of this thesis, Canadian banks operate under the authority of the Office of the Superintendent of Financial Institutions (OSFI) and the European Banking Authority (EBA) in conjunction with local central banks governs banks within the European Union. In the United States regulatory authority is more fragmented as banks are governed and supervised by several institutions, although overarching authority lies in the hands of the Federal Reserve Bank (FED). Without exception each bank is therefore, aside of Basel regulation, subject to various federal regulatory laws and acts.

2.2 Capital in banking

If we would live in a world as outlined by Modigliani and Miller (1958) the funding mix of banks would be irrelevant. [4] Although this might be an appropriate assumption for many industries, the banking sector is unique in the sense that banks are leveraged by nature, making capital needs on both side of the balance sheet apparent. Especially as capital has the ability to serve as a buffer against losses (Dewatripont & Tirole, 1994; Bernanke, 2012), capital is essential to the stability of banks. Subsequently is higher capital, amongst other things, associated with higher- lending, liquidity creation and bank values (Thakor, 2014). There furthermore is a large body of evidence that capital is particularly essential for bank stability during banking crisis, as research indicates that banks with higher capital ratios have a higher probability of survival (see e.g. Berger & Bouwman, 2013; Demirgüç-Kunt, Detragiache, & Merrouche, 2010).

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[2] The Group of Twenty (G-20) is a consortium of industrialized countries that co-operate and debate on international financial matters. The consortium is composed of the original members of the G-10, as well as Argentina, Australia, Brazil, China, India, Indonesia, Mexico, Russia, Saudi Arabia, Turkey, South-Africa and South-Korea.

[3] G-20, "Declaration of the Summit on Financial Markets and the World Economy", 15 November 2008.

[4] Referring to the often appraised theorem of Modigliani and Miller (1958) on capital structure, in which the capital structure of firms is irrelevant to the value of the firm.

2.2.1 Regulatory capital

Despite progress in the research on banking, there is still no consensus on whether bank capital should be regulated, and if so in which manner. Nonetheless, there are two arguments often presented for regulating bank capital: the inability of depositors to monitor banks and the risk of a systemic crisis. More specifically, as shown by Diamond and Dybvig (1983) are banks exposed to runs, which could possibly destabilize the financial system. Deposit insurance can fortunately credibly prevent runs.[5] Although a safety net such as deposit insurance clearly provides benefits, it has serious costs as well. As Admati, DeMarzo, Hellwig and Pfleiderer (2013) note "a subsidized safety net leads to the danger of the privatization of profits and socialization of costs." By providing such safety net banks are obviously provided an incentive to maximize risk, and hence profits, as they are insulated from the downside risk by the provided safety net. Capital requirements can mitigate this problem as capital has the ability to impact the risk-incentives as well as the soundness of banks (Santos, 2000). Regulatory capital is therefore, following research of Berger et al. (1995), hereinafter defined as "capital that should reduce the bank's moral hazard incentives to exploit the protection of the safety net by undertaking excessive risk, and should therefore ultimately aim at enhancing bank stability and align banks incentives. "

2.2.2 Capital structure

Any review on the capital structure of financial institutions is not complete without mentioning the often-appraised theorem on bank capital of Diamond and Rajan (2000). Banks are, as previously stated, vulnerable to bank runs and as explained by Diamond and Rajan (2000) banks can create liquidity precisely because deposits are fragile. This uncertainty creates instability, which institutions have to insulate themselves from with capital. Although greater bank capital reduces the probability of financial distress, it also reduces the possibility of liquidity creation. In their model, optimal bank capital structure therefore

[5] Diamond (2007) provides a detailed exposition of the Diamond-Dybvig model in which he elaborates on why deposit insurance would prevent a bank run for occurring.

trades off the ability of liquidity creation and the costs associated with bank distress. But as Mishkin (2000) notes: "Banks also hold capital because they are required to do so by regulatory authorities. Because of the high costs of holding capital, bank managers often desire to hold less bank capital than is required by the regulatory authorities. In this case, the amount of bank capital is determined by the bank capital requirements." According to the capital buffer theory (Marcus, 1984; Milne & Whalley 2002) banks will furthermore maintain a level of capital above the required minimum, or when undercapitalized try to rebuild an appropriate capital buffer. Research has provided evidence that the way in which financial institutions adjust towards their targeted capital buffer largely depends on the initial buffer they hold (Jokipii & Milne, 2009). More specifically, Heid, Porath, and Stolz (2004) find evidence from the German banking sector that banks with low capital buffers try to rebuild an appropriate capital buffer by raising capital while simultaneously lowering risk. In contrast it is found that banks with high capital buffers try to maintain their capital buffer by increasing risk when capital increases. It is therefore expected that the initial buffer that banks hold will largely affect the impact of capital on bank stability. There are however, as can be concluded from forthcoming parts, large cross-country differences in the definition of capital at risk. As De Jonghe and Öztekin (2013) provide evidence that banks adjust their capital structure faster when capital requirements are more stringent, furthermore promoting banking stability to a greater extent (Barth et al., 2006; Brewer et al., 2008), it is furthermore expected that the stringency of capital regulation in addition will have a positive impact on bank stability, as well as the impact of capital on bank stability.

2.3 The leverage ratio

Capital ratios have long been a valuable tool for assessing the safety and soundness of banks, i.e. the informal use of capital ratios by bank regulators and supervisors goes back well over a century (Mitchell, 1909). Capital ratios can be broadly divided into two groups: un-weighted and risk-weighted capital ratios. Concerning the capitalization of banks there are three types of leverage: balance sheet, economic, and embedded leverage. No single capital ratio can capture all three elements simultaneously; most definitions of the leverage ratio in fact only

capture balance sheet leverage (D'Hulster, 2009). Although regulatory focus is primarily on the risk-weighted capital ratio, some academics have argued that the idea that there is a more suitable metric to assess bank soundness than the leverage ratio is misguided.[6] Although the leverage ratio in theory could benefit bank stability, which will be further elaborated on in forthcoming parts, only a small proportion of countries worldwide impose a minimum leverage ratio requirement on their banks. Especially the continent Europe is, as observable from figure 1, lagging compared to their continental peers in terms of regulatory imposing the leverage ratio.

Leverage ratio across continents
% countries per continent with a minimum leverage ratio requirement

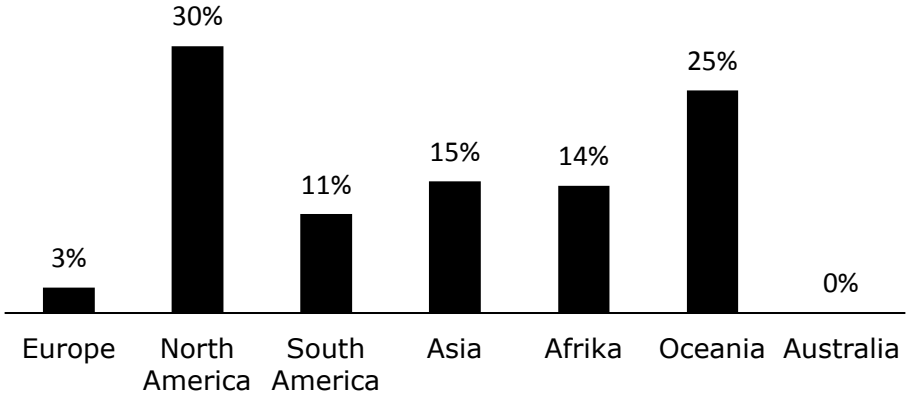

Figure 1 Leverage ratio across continents.[7]

In order to provide some insight in the minimum leverage ratio requirement, the forthcoming part will elaborate on its use and definition within different regulatory frameworks and jurisdictions. As focus of this thesis, as well as the associated sample, is on countries from the European Union, the United States and Canada, solely regulation applicable in those countries will be considered heron after.

[6] See e.g. Herring (2010); Atkinson and Blundell-Wignall (2008).

[7] Adapted from the dataset "Bank regulation and Supervision", constructed by Barth, Caprio and Levine (2007). The dataset can be retrieved from www.econ.worldbank.org

2.3.1 Current regulation

Basel III

The Basel III framework introduced, for the first time, an internationally agreed-upon leverage ratio. The leverage ratio is according to the Bank for International Settlements (2013) intended to "restrict the build-up of leverage in the banking sector to avoid destabilizing deleveraging processes that can damage the broader financial system and the economy; and reinforce the risk-based requirements with a simple, non-risk based *backstop measure*." Banks are, as can be derived from figure 2, no longer considered viable below this backstop level. The Basel Committee is of the view that a simple leverage ratio framework is essential as well as complementary to the current risk-weighted framework (BCBS, 2014).

Figure 2 Capital adequacy rules.[8]

The leverage ratio within the Basel framework is a non-risk based measure of the ratio of a bank's Tier 1 capital to its exposure measure, including both on- and off-balance sheet exposures and furthermore is netting of loans and deposits within this framework not allowed. Although the leverage ratio is introduced in the Basel III regulatory framework it currently falls under Pillar II, i.e. non-mandatory requirements, albeit the committee has declared the intention to migrate the requirement to Pillar I in the near future (BCBS, 2013).

United States

The United States employs a simple leverage ratio, expressed as a minimum ratio of Tier 1 capital to total average adjusted assets. Adjustments to assets represent deductions that include goodwill, investments deducted from Tier 1 capital, and deferred taxes (D'Hulster, 2009). The leverage ratio is set at three percent for banks rated strong and at four percent for all other banks. Banks'

[8] Adapted from the consultative document "Revised Basel III leverage ratio framework and disclosure agreements" by the Bank for International Settlements (2013).

actual leverage ratios are typically higher than the minimum because banks are additionally subject to prompt corrective action rules, requiring them to maintain a minimum leverage ratio of five percent in order to be considered well capitalized (FDIC, 2014). The leverage ratio does not take into account off-balance-sheet exposures and a higher ratio may in addition be required for any institution if warranted by its risk profile or circumstances (D'Hulster, 2009). When the Dodd-Frank Wall Street Reform and Consumer Protection act was passed in 2010, Former FDIC chairman Sheila Bair almost single handedly hold on to the leverage ratio and assured that this capital ratio was added to the Dodd-Frank act as well (Herring, 2010).

	Dodd-Frank		Basel III
	Well-capitalized	Adequately capitalized	Minimum requirements
Common equity Tier 1 (% of RWA)	n.a.	n.a.	4.5%
Tier 1 ratio (% of RWA)	6%	4%	6%
Total capital ratio (% of RWA)	10%	8%	8%
Leverage ratio (% of total exposures)	5%	4%	3%

Figure 3 Comparison of Dodd-Frank and Basel III capital requirements.[9]

The leverage ratio within this framework compares, as observable from figure 3, well with the Basel III standards although any comparison should be treated with caution since the definitions of the capital instruments and accounting treatments (GAAP versus IFRS) do not always coincide (Herring & Kane, 2011).

Canada

Canadian banks are subject to a regulatory ceiling on their leverage, namely an assets-to-capital multiple that is calculated by dividing the total assets by total (Tier 1 and 2) capital. The maximum multiple is set at twenty, which translates into a leverage ratio of five percent, although the Office of the Superintendent of Financial Institutions may grant exemptions (OSFI, 2014). Because measures of risk are imperfect, the Canadian regulator believes that the leverage ratio can function as an objective measure to complement the risk-weighted Basel capital

[9] Adapted from public law 111-203 "Dodd-Frank Wall Street Reform and Consumer Protection act", which passed U.S. congress in 2010.

requirements (Dickson, 2009). The Canadian leverage ratio is a more comprehensive measure than that of the United States because it, due to the partial inclusion of off-balance sheet commitments, also measures economic leverage to some extent (Breuer, 2000). The Canadian multiple is therefore regarded as more conservative than the leverage ratio of the United States. It is interesting to note that Mark Carney (2008), Governor of the Bank of Canada, is convinced that Canadian banks are "healthier than their international peers because their leverage is markedly lower." The stringency of Canada's leverage ratio has been indicated as one factor, in addition to sound supervisory and regulatory practices and conservative lending of banks, contributing to the strong performance of the Canadian financial sector during the financial crisis (D'Hulster, 2009).[10]

Europe

According to the Centre for European Policy Studies (2012) is the banking sector in Europe in need of rigorous reforms as unprecedented levels of state aid and monetary stimulus have up to now not lead to significant stabilization of the financial market. Yet, according to Ayadi, Arbak, and de Groen (2012) the European Union has up to now failed to deliver a regulatory response as rigorous as asked for and justified by the current condition of the financial sector, and they therefore propose a binding leverage ratio. This leverage ratio should restrain excessive leverage that is, according to figure 5, significantly higher in Europe. But, "it was always the French and the Germans," grumbles a senior financial regulator, blaming representatives from those two countries for overthrowing international efforts to increase capital ratios for

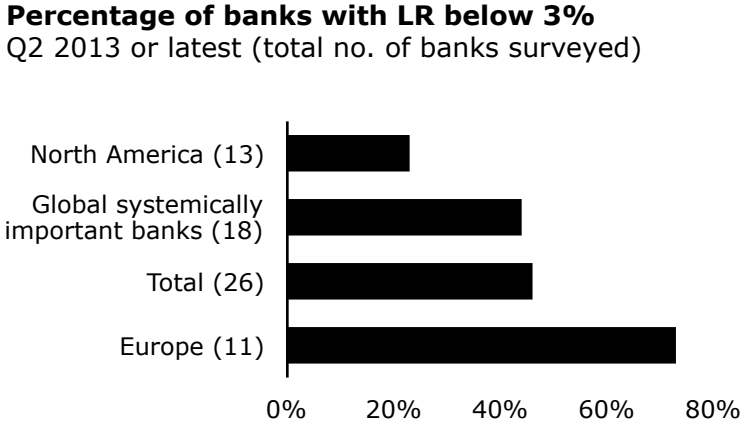

Figure 3: source GFMA (2013)

[10] See also, International Monetary Fund (2009) Canada: Article IV consultation.

banks, as well as introducing a leverage ratio.[11] On competitive grounds, many European countries strongly object to imposing the leverage ratio as due to the differences in accounting standards leverage of European banks is often overstated in comparison with the United States and Canada. This difference is in large part attributable to the different treatments in accounting for derivative positions as within the GAAP framework many derivative positions are permitted to be netted against one another but European regulators permit derivatives positions to be netted out only when there is a legally binding requirement to do so (Herring & Kane, 2011).

2.3.2. A roadmap to stability?

There is, as previously mentioned, a large group of policy makers and researchers who claim that the leverage ratio is at the root of the strong recovery of the banking sector of the United States and Canada (see e.g. Herring, 2010; Bordeleau et al. 2009). As capital has the ability to serve as a buffer against losses (Dewatripont & Tirole, 1994), it seems straightforward to conclude that assuring a minimum of such capital would enhance bank stability.
Berger et al. (1995) however claim that the relationship between the ratio of equity to assets and bank safety is often relatively weak. Moreover can the leverage ratio in theory provide benefits as well as drawbacks to bank stability. Whether the benefits outweigh the drawbacks ultimately dictate whether banking stability is truly enhanced by a minimum leverage ratio requirement, hence whether the previously mentioned claim is truthful. In order to get a clearer grasp of the impact of a minimum leverage ratio requirement on bank stability, the forthcoming part will first elaborate on the potential benefits and subsequently on the potential drawbacks of such risk un-weighted capital requirement on bank stability.

[11] Quote retrieved from "Leverage ratios leavened", by the Economist (2014).

2.3.3 Benefits leverage ratio

Most prevalent benefit of the leverage ratio is its simplicity, especially as modern finance is complex, perhaps even too complex (Haldane & Madouros, 2012). This cycle of increasing complexity is, as the financial sector is constantly seeking to innovate, most likely not to be reversed in the near future. Moreover is regulation of modern finance complex, surely too complex (Haldane & Madouros, 2012). The amount of exemptions and implementation choices available within each regulatory framework only adds up to this complexity. This makes comparison of financial institutions a challenge for regulators and avoiding regulation a challenge for financial institutions. Blundell-Wignall and Roulet (2012) therefore argue that the current capital regulation is "excessively complex, rendering it ineffective, and that a simple leverage ratio should therefore be the primary regulatory tool for bank capital." Although objective of this thesis is not to suggest that the risk-weighted assets framework should be replaced by a leverage ratio, it is suggested that adding simplicity to complexity could intuitively provide benefits to bank stability. The Basel Committee on Banking Supervision (2009) furthermore advocates that the leverage ratio can serve as a safeguard to the system against failure in risk management. Such failures appear when risk assessments, as well as risk-weighted assets, turn out to understate the true risk at stake, such as happened with mortgage-backed securities in the run-up of the financial crisis. As discussed by Brealey (2006) and Admati and Hellwig (2013) is the system of risk-weighted assets complex and easily manipulable, e.g. Atkinson and Blundell-Wignall (2010) show that banks' ability to arbitrage the capital weights to reduce capital and expand leverage is extensive. History has, in conjunction with empirical research, brought forward additional evidence of this as many banks that faced risk-weighted regulatory requirements became increasingly leveraged in the run-up of the financial crisis, leading to increased instability in the banking sector (Hildebrand, 2008). Excessive leverage that was even politically acknowledged as Chairman of the Financial Stability Forum Mario Draghi summarized the view of the FSF when he said: "Our conviction is that […] institutions have

accumulated a level of leverage that was both misperceived and excessive." [12] A leverage ratio serves, as noted by Hildebrand (2008) as a safety backstop against those shortcomings of risk-weighted requirements, and can additionally constrain excessive leverage. Bank stability has furthermore been especially adversely affected in the past decade by financial innovations, particularly as some financial innovations enabled banks to make "cosmetic" adjustments to increase their reported capital ratios without actually enhancing their soundness (Jones, 2000). Financial innovations that were a result of investment bankers that spend a decade to invent products that looked enough like capital for regulators to accept it, but enough like debt that the tax authority would permit them to be deducted (Herring, 2010). This concept of regulatory arbitrage is not just a generation X phenomenon as Plato[13] already noted:

Good people do not need laws to tell them to act responsibly, while bad people will find a way around the laws.

Regulatory arbitrage will therefore always be a major feature of society and especially in a sector in which the creation of value is such peculiar process. Although regulatory arbitrage cannot be entirely prevented, measures can be taken to minimize the possibility of regulatory arbitrage. As advocated by Acharya et al. (2010) can a leverage ratio restrain the banking sector in their attempts to dodge capital regulation, therefore limiting the possibility of regulatory capture. Altogether can even a well-designed risk-weighting framework soon become outdated as new financial innovations are introduced (Estrella et al., 2002), but the risk-insensitiveness of the leverage ratio can serve as a backstop for this. As banks have more of their own capital invested they furthermore bear a larger part of the downside risks themselves, therefore reducing the banks' benefit of understating risks (Blum, 2008). Or as Demirgüç-Kunt et al. (2010) put it, "by forcing bank owners to have some skin in the game

[12] Mario Draghi, chairman of the Financial Stability Forum, in his address to the G7 ministers and governors, April 2008.

[13] Quote by Plato (429 - 347 BC), influential Greek philosopher and writer.

minimum capital requirements should curb incentives for excessive risk taking created by limited liability and amplified by deposit insurance and bailout expectations. "

2.3.4 Drawbacks leverage ratio

Although the leverage ratio in theory provides some excellent benefits, there furthermore are potential drawbacks associated with the leverage ratio. European banks, as previously mentioned, oppose to the leverage ratio as differences in accounting standards tends to lead to an overstatement of their assets. A principal issue related to the leverage ratio in combination with accounting standards therefore is the potential impact of netting, especially through derivatives exposures as derivatives represent a significant proportion of the balance sheet totals of banks (Ayadi et al., 2012). The leverage ratio will therefore not capture the full amount of capital at risk as long as netting is allowed, hence account for bank stability. The leverage ratio furthermore implicitly assumes that the capital needs of a bank are directly proportional to its level of assets; in effect disadvantaging conservative banks for holding high-quality assets. This would subsequently provide banks with an incentive to move towards higher risk-strategies. Haldane and Madouros (2012) therefore advocate that the main case against the leverage ratio is that it might encourage banks to increase their risk per unit of assets by shifting from assets with low risk weights to those with higher risk weights. Although banks in the United States and Canada are additionally constrained by risk-weighted capital requirements, this does not fully account for the risk-incentive provided by the leverage ratio. More specifically, Kiema and Jokivuolle (2014) and the Global Financial Markets Association (2013) provide evidence that the leverage ratio might induce banks with low-risk lending strategies to diversify their portfolios into high-risk loans until the leverage ratio is no longer the binding capital constraint. Whether the leverage ratio is the binding constraint for banks will therefore largely impact the risk-incentive provided by this capital requirement. Especially as Kiema and Jokivuolle (2014) provide evidence that low-risk lending rates significantly increase and high-risk lending rates fall when the leverage ratio becomes the binding measure, in effect providing banks that are constrained by the leverage

ratio with an additional incentive to move towards higher risk lending strategies. Although the previous section suggest straightforward to conclude that a leverage ratio would incentivize risk taking for banks, Bordeleau et al. (2009) find that despite the incentive to shift towards riskier assets there is little evidence that the leverage ratio has led to this type of behavior in the run-up of the financial crisis in the Canadian banking sector.

2.4 Hypotheses

Altogether is objective of this thesis to assess the impact of a minimum leverage ratio requirement on bank stability. There is, as previously mentioned, a large group of policy makers and researchers who claim that the leverage ratio is at the root of the strong recovery of the United States' and Canadian banking sector.[14] It is in addition advocated that this risk un-weighted capital requirement could be a credible supplement to the current risk-weighted regulatory capital framework.[15] Nonetheless has the preceding literature review indicated that the leverage ratio can likewise provide incentives to banks that in effect would harm bank stability. In order to shed some light on the perspective this thesis therefore intents to answer the following research question:

Does a minimum leverage ratio contribute to bank stability?

The United States and Canada provide an excellent benchmark to assess this as these countries already impose such risk un-weighted minimum capital requirement. An event study on the potential impact of the leverage ratio on bank stability is empirically in executable as the leverage ratio requirement is phased in over a long period and accompanied by a variety of transition agreements. The main thesis has furthermore to be assessed in a creative manner due to the fact that banks that are not subject to a minimum leverage ratio requirement still possess equity as well as assets. More specifically is the impact of the requirement therefore assessed by investigating whether this requirement has led to significant changes in the inquired relationship between

[14] See e.g. Herring (2010) and Bordeleau et al. (2009)

[15] See e.g. Acharya et al. (2010), Bank for International Settlements (2014) and Hildebrand (2008)

capital and stability for banks that are subject to a minimum leverage ratio requirement.

Banks are unique in the sense that they are leveraged by nature, which makes capital needs on both sides of the balance sheet apparent. As capital has the ability to serve as a buffer against losses (Dewatripont & Tirole, 1994; Bernanke, 2012) it is expected that better capitalized banks, i.e. banks that possess a higher leverage ratio, will more easily absorb shocks, which is expected to result in greater bank stability. As a result, the first hypothesis is defined as follows:

H1. The leverage ratio is positively related to bank stability.

There are, as previously mentioned, some credible benefits and drawbacks to bank stability associated with imposing a minimum leverage ratio requirement. Overall is "putting some skin in the game" however expected to have a positive effect on bank stability (Demirgüç-Kunt et al., 2010). Banks that are subject to a minimum leverage ratio requirement are in theory restrained in their opportunities for regulatory capture but at the same time are provided a risk-incentive as well. Which effect outweighs the other will ultimately dictate whether a minimum leverage ratio requirement promotes bank stability. This unfortunately entirely depends on whether the leverage ratio is the binding constraint for banks. Albeit the literature review brought forward conflicting views on the impact of a minimum leverage ratio requirement on bank stability, it is nevertheless expected that this leverage ratio requirement has led to a significant *change* in the leverage-stability relationship for banks that are yet subject to a minimum leverage ratio requirement. The second hypothesis is therefore defined as follows:

H2. The relation in H1 is significantly different for banks that are subject to a minimum leverage ratio requirement.

It is furthermore expected that the capital adequacy of banks will have a mediating effect on the preceding assessed relationship between leverage and bank stability. Following the capital buffer theory, Heid et al. (2004) find evidence from the German banking sector that undercapitalized banks try to

rebuild their capital buffer by increasing capital and simultaneously lower risk, while adequately banks try to maintain their capital buffer by increasing risk. It is therefore expected that undercapitalization will have a significant positive mediating influence on the leverage ratio as undercapitalized banks are expected to increase capital while simultaneously increase stability by lowering risk. Subsequently can the following hypothesis be defined as:

H3. The relation in H1 is more positive for banks that are undercapitalized, i.e. their Tier 1 capital ratio is below the regulatory threshold of 6%.

Whether the leverage ratio impacts bank stability largely depends on whether the leverage ratio is the binding constraint for banks. When banks' Tier 1 capital ratio is below six percent the leverage ratio is evidently the binding constraint for those banks. The leverage ratio furthermore provides banks in theory a risk-incentive when the leverage ratio is the binding constraint (see e.g. Kiema & Jokivuolle, 2014), albeit it could theoretically curb risk-incentives as well. If the leverage ratio requirement truly impacts bank stability in the United States and Canada, undercapitalization should provide banks a significantly different risk-incentive in the United States and Canada. It is therefore expected that undercapitalization has a significant different impact on bank stability for banks from the United States and Canada in comparison with banks from the European Union. Hence, hypothesis 4 will be:

H4. The relation in H3 is significantly different for banks that are subject to a minimum leverage ratio requirement.

It can furthermore be concluded from section 2.3.1 that there are large cross-country differences in the deductions and allowances that are permitted in calculating the capital at risk of banks. The Canadian leverage ratio is for example regarded as a more comprehensive measure than the United States' leverage ratio as it additionally measures economic leverage to some extent (Breuer, 2000). Although main focus of this thesis is on the impact of imposing a minimum leverage ratio on bank stability, it is acknowledged that there are other aspects of capital regulation that conjunctionally affect this relationship. As capital promotes banking stability to a greater extent when capital regulation is

more stringent (Barth et al., 2006; Brewer et al., 2008), it is expected that the stringency of capital regulation concerning the capital at risk will have a significant mediating impact on this relationship. The capital stringency index that will be employed in the following hypothesis measures whether the capital requirements "reflect certain risk elements and deduct certain market value losses from capital before minimum capital adequacy is determined (Barth et al., 2002)." It is therefore expected that by assessing the relationship between the capital stringency index of Barth et al. (2002), leverage of banks and bank stability, an indication can be obtained about whether the leverage ratio has led to more banking stability in the United States and Canada, and whether this relationship is mitigated by the way in which the capital at risk is defined. Subsequently is the last hypothesis of this empirical study defined as:

H5. The relation in H1 is stronger for banks in countries that possess more stringent capital regulation.

3. Sample

The empirical model is a basic cross-sectional regression using bank level data. The dependent variable is the z-score, which is considered a measure of bank's soundness. Information on banks' balance sheets and income statements is obtained from Bankscope[16], a database compiled by Fitch/Bureau Van Dijk from publicly available data. The bank-specific data is linked to various country-level variables that contain information on the macroeconomic environment, obtained from the World Bank database. The bank-specific data is additionally linked to the capital regulatory framework. More specifically is data from the Bank Regulation and Supervision database obtained, which is constructed by Barth, Caprio, and Levine (2013). Barth, Caprio, and Levine (2001) assembled the first extensive cross-country database on the characteristics of the supervisory and regulatory framework and the data, which comes from a survey of bank supervisors, measures the presence or absence of a series of regulatory features. Some countries in the sample have furthermore yet imposed a leverage ratio,

[16] Retrieved from http://wrds-web.wharton.upenn.edu

and in order to make a fair Belgium, which has a leverage ratio imposed depending on third party funds and which varies according to volumes, is excluded from the sample.[17] Filtering the bank-specific data and matching it with the country-level data yields a sample of 11.183 banks from 27 countries observed over the period 2003-2013, totaling 115.150 bank-year observations. Details on the composition of the sample in terms of number of companies and bank's business models per country can be found in table II and table III of the appendix.

3.1 Methods

First, if banks report their information at the consolidated level, the unconsolidated entries of the group are deleted to avoid double counting. Second, bank-year observations with missing data on basic variables are dropped. To ensure reasonable cross-sectional variation are firms with information on less than 8 bank-year observations deleted as well. All variables are winsorized at the 1% and 99% levels to mitigate the impact of outliers. Although most of the bank-specific variables are ratios, variables in levels (e.g., total assets) are converted into constant inflation-adjusted millions of U.S. dollars.

3.2 Dependent variables

Research of Laeven and Levine (2009) and Strobel (2014) served as a guideline for defining the measure of bank's soundness. They primarily measure bank risk by using the z-score of each bank, which equals the return on assets plus the capital asset ratio divided by the standard deviation of asset returns. It can be interpreted as the number of standard deviations below the mean by which returns would have to fall to wipe out bank equity (Boyd, De Nicolò, & Jalal, 2006). Following their research, the z-score is calculated as follows:

$$Z = \frac{ROA + {Equity}/{Total\ Assets}}{\sigma(ROA)}$$

[17] See Barth, Caprio and Levine (2008), dataset can be retrieved from: http://econ.worldbank.org/

Subsequently indicates a higher z-score that the bank is more stable. As independent variable in latter regressions is the leverage ratio, equity/ total assets is left out from the z-score calculation, as the independent and dependent variables would otherwise highly correlate. From a practical implementation point of view, Laeven and Levine (2009) and Houston et al. (2010) recommend the use of the log of the z-score over the simple z-score as the distribution of the simple z-score is heavily skewed, whereas the log of the z-score is not. Another measure of bank stability is the amount of non-performing loans (Berger, Klapper, & Turk-Ariss, 2009). The International Monetary Fund (2005) employs the following definition of a non-performing loan: "A loan is nonperforming when payments of interest and/or principal are past due by 90 days or more, or interest payments equal to 90 days or more have been capitalized, refinanced, or delayed by agreement, or payments are less than 90 days overdue, but there are other good reasons—such as a debtor filing for bankruptcy—to doubt that payments will be made in full."[18] This alternative measure of bank stability is defined as a percentage of gross loans. This measure has been identified as a financial soundness indicator by the International Monetary Fund (2004), and an increasing ratio is regarded as "a signal of deterioration in the quality of the credit portfolio." Subsequently is a decrease in this measure regarded as a sign of increasing bank stability, although mostly through an increase in the quality of the asset side of the balance sheet.

3.3 Independent variables

Of prime interest is the leverage ratio, which is a measure of how leveraged the bank is. Although there is, as previously mentioned, still no consensus on the definition of safe capital that could provide a buffer for losses, it is chosen in the empirical part of this research to employ the conservative and simple measure of bank leverage, i.e. the ratio of total equity to total assets. To assess the stringency of capital regulations regarding the capital at risk is the capital stringency index employed, which is an index of regulatory oversight of bank

[18] International Monetary fund (2005). The Treatment of Nonperforming Loans. BOPCOM-05/29

capital developed by Barth et al. (2002). The measures are obtained from the database of the corresponding paper "Bank Regulation and Supervision in 180 countries from 1999 to 2011" of Barth et al. (2013).[19] The capital stringency index employed in the regression does not measure statutory capital requirements; it instead measures the regulatory approach to assessing and verifying the capital at risk in a bank.[20] The index is measured on a 0-7 interval and higher values indicate greater stringency of capital regulation. The specific calculations and questions employed to construct the index can be found in table I of the appendix. A set of control variables is furthermore included to control for various bank and country characteristics that might affect bank stability. Details on all control variables, as well as the independent and other dependent variables can be found in table IV of the appendix. First control variable relates to the size of the bank as Ayuso, Perez, and Saurina (2004) offer evidence that larger banks hold lower levels of capital. To control for the influence of market discipline on bank stability the interbank ratio is furthermore included, reflecting the proposition that other banks have the ability to monitor their peers in the interbank market (Nier & Baumann, 2006). The incentive for banks to monitor each other is a result of the fact that interbank deposits are typically not covered by deposit protection schemes. To control for the efficiency of banks is the cost to income ratio additionally included in the regressions. As previous research (see e.g. Ratnovski & Huang, 2009) has indicated that the funding structure of banks largely impacts the stability of banks, variables to control for the funding structure are furthermore added. Especially the dependence on wholesale funding has been regarded as leading to increased risk for financial institutions, illustratively were British banks that relied more on wholesale funding more affected by the collapse of Northern Rock (Yorulmazer, 2008). Although reliance on wholesale funding cannot be assessed by variables obtainable from Bankscope, it is accredited that reliance on wholesale funding can be approximated by a bank's dependence on its safer rival, customer deposits. A bank that relies less on customer deposits is in this case most likely to depend

[19] The paper as well as the associated database can be retrieved from: http://econ.worldbank.org/

[20] Laeven and Levine (2008). Bank governance, regulation and risk taking.

more on wholesale funding. A measure of income diversity that follows research by Laeven and Levine (2005) is furthermore included to control for differences in the structure of the bank's income.[21] This variable captures the degree to which banks diversify from traditional lending activities to other activities and higher values of the variable correspond to a higher degree of income diversification. The macroeconomic outlook also affects bank soundness, e.g. high inflation and rapid credit expansion have been found to be associated with bank instability (see e.g. Demirgüç-Kunt & Detragiache, 1998). Annual inflation and GDP growth are therefore in addition added as control variable.

4. Research design

This section provides the research design used to assess the impact of a minimum leverage ratio requirement on bank stability. In section 4.1 is the sample design explained and in section 4.2 will the regression model and design be explained.

4.1 Sample design

The sample represents an unbalanced panel of yearly bank observations. In this research is a panel-data analysis employed, which is defined by Podesta (2002) as having repeated observations (e.g. years) on fixed units. This means that the analysis combines the time series for several cross-sections (Podesta, 2002). In this research the times series are years and the cross-sections are banks. The first and most important advantage of a pooled data analysis is that it reduces possible problems that can occur when having a small sample. Another advantage is that the analysis is not conducted at one point in time, but an analysis is done for all firms through time (Pennings, Keman, & Kleinnijenhuis, 2005). Although the errors are typically independent from one period to the next, they however tend to be correlated and heteroscedastic (Podesta, 2002). And according to Petersen (2005) there are two general forms of dependence

[21] The income diversity measure is calculated as follows:
Income diversity= 1 – (net interest income-other operating income)/total operating income

that are most prevalent in financial panel data applications such as this thesis. The residuals of a given firm may be correlated across years for a given bank or alternatively may the residuals of a given year be correlated across different banks. In order to control for this are standard errors clustered on bank level. As the time effect in the sample is fixed[22], including dummy variables for each time period will thereafter remove, as previously shown by Petersen (2005), the time-series dependence. As thereafter there only remains an in-sample firm fixed effect, the standard errors clustered on bank level will theoretically produce unbiased results. As can be derived from table II of the appendix represent banks from the United States a large proportion of the employed sample. To account for this overrepresentation and by doing so making sure that the assessed relationships are not biased, probability weights per country are added to each regression. Following research by Beck and de Jonghe (2013) are the independent variables furthermore lagged one year to mitigate concerns of reverse causality. To assess whether multicollinearity is present within the model, the collinearity matrix can provide some initial insight. But following Berenson, Levine and Krehbiel (2005) a superior method for measuring multicollinearity is defined as by looking at the Variance Inflation Factor (VIF) of each variable. A high correlation between two or more of these variables indicates that it becomes difficult to determine the separate effect of the independent variables on the dependent variable, and would subsequently result in removal of the highly correlating variables from the analysis. No problem of multicollinearity between the independent, dependent and control variables exists when the tolerance (1/VIF, a VIF related multicollinearity measure) is above its threshold of 0.2, and the VIF is below its threshold of 5 (Hair, Anderson, Tatham, & Black, 1995). As can be deduced from table IV of the appendix, in which the VIFs per variable are presented, not all variables included in this analysis pass the multicollinearity test, hence it is necessary to exclude GDP, inflation and deposits from banks from the set of control variables in order to ensure the reliability of the forthcoming analysis. The pairwise correlation matrix that is presented in table V of the appendix thereafter shows that no high

[22] The existence of time-fixed effects in this dataset is proven by employing the test-parm function in Stata

correlation exist between the remaining variables that are included in the analysis. All numbers are closer to 0 instead of -1 or 1, which indicates the presence of low correlation between the variables. The choice for pairwise correlation is a result of the large amount of missing data on some principal variables. As default in a standard correlation matrix is list wise deletion of missing values, as opposed to pairwise deletion in a pairwise correlation matrix, it is believed that pairwise correlation coefficients give better insight in the underlying correlations of this sample.

4.2 Regression model

This study will first examine the relationship between the leverage ratio and bank stability by carrying out an OLS regression analysis with the z-score as dependent and the leverage ratio as independent variable. In all regressions will the ratio of non-performing to gross loans furthermore be employed as an alternative measure of bank stability. The model that will be tested is as follows:

$$Z_{i,j,t} = \alpha + \beta 1\ LR_{i,j,t} + \beta 3\ controls_{i,j,t} + \varepsilon_{i,j,t} \quad (1)$$

In this model, $Z_{i,j,t}$ is the z-score of bank i in country j at time t, indicating the banks' stability. $LR_{i,j,t}$ is the leverage ratio of bank i in country j at time t, and β1 is the coefficient that describes the influence of the leverage ratio on the z-score. A set of control variables is furthermore added to the regression. In addition, α is the intercept and $\varepsilon_{i,j,t}$ is the error term of bank i in country j at time t. The second model will include interaction dummies for Canada and the United States. By doing so is the effect of the leverage ratio on stability of banks from the United States, Canada and Europe compared.

$$Z_{i,j,t} = \alpha + \beta 1\ LR_{i,j,t} + \delta 1\ US\ dummy * LR_{i,j,t} + \delta 2\ CA\ dummy * LR_{i,j,t} + \beta 3\ controls_{i,j,t} + \varepsilon_{i,j,t} \quad (2)$$

Where the dummy variables are 1 when the bank is from the United States or Canada, and their respective δ's are the additional effect that an increase in the leverage ratio has on bank stability for these countries. To assess whether the impact of the leverage ratio on stability is stronger for undercapitalized banks, an interaction dummy is introduced for undercapitalized banks (i.e. Tier 1 capital ratio <6%).

$$Z_{i,j,t} = \alpha + \beta 1\ LR_{i,j,t} + \delta 3\ T1\ dummy * LR_{i,j,t} + \beta 3\ controls_{i,j,t} + \varepsilon_{i,j,t} \quad (3)$$

Where $\delta 3$ is the additional impact of an increase in the leverage ratio on stability for undercapitalized banks. In the next regression, the two preceding regressions are combined. As there is only one Canadian bank in our sample undercapitalized are The United States and Canada merged into one dummy variable, representing in-sample countries with a minimum leverage ratio already imposed.

$$Z_{i,j,t} = \alpha + \beta 1\ LR_{i,j,t} + \delta 4\ dummy\ LR\ imposed * LR_{i,j,t} + \delta 3\ T1\ dummy * LR_{i,j,t} * \delta 4\ dummy\ LR\ imposed + \beta 3\ controls_{i,j,t} + \varepsilon_{i,j,t} \quad (4)$$

In the last regression is it assessed whether the impact of the leverage ratio on bank stability is stronger in countries that have more capital stringent regulations. To assess the capital stringency of regulations, the Capital Regulatory index of Barth, Caprio and Levine (2008) is employed.

$$Z_{i,j,t} = \alpha + \beta 1\ LR_{i,j,t} + \beta 2 * CR_{j,t} * LR_{i,j,t} + \beta 3\ controls_{i,j,t} + \varepsilon_{i,j,t} \quad (5)$$

5. Findings

Following the previously outlined regression and sample design, this chapter will first present the summary statistics of all variables that are employed in this thesis. In the latter part will the actual regressions, as presented in section 4.2, be tested. In all regressions will bank stability be assessed by the z-score and alternatively by the ratio of non-performing to gross loans. Objective of this empirical study is to assess whether the leverage ratio has a significant positive impact on bank stability and whether this relationship is different for undercapitalized banks. Of special interest is the impact of the regulatory environment on these previously stated relationships. Specifically are the mediating effect of a regulatory minimum leverage ratio requirement and the stringency of capital regulation on bank stability tested. In order to do so is the remainder of this empirical study structured as follows. In section 5.2 is the relationship of the leverage ratio on stability, as well as cross-country differences, assessed. In section 5.3 is the impact of the leverage ratio of undercapitalized banks on bank stability assessed, as well as cross-country

differences. Lastly, section 5.4 explores the impact of capital regulation stringency on the leverage ratio-bank stability relationship. Furthermore can details on the employed variables and associated calculations be found in table III of the appendix.

5.1 Descriptive statistics

Table 1 reports the summary statistics of all variables that are employed in this thesis. These values represent the representative number of observations, standard deviation, minimum and maximum values for each of the variables. Supplementary data on all variables can in addition be found in table III of the appendix.

Table 1
Summary Statistics

This table presents the number of observations (N), mean, standard deviation, minimum and maximum values for each variable employed in this empirical study.

	N	Mean	Std. Dev.	Min	Max
Z-score	115150	1.668	0.493	0	2.84943
Leverage ratio	115150	11.242	9.382	1.1	90.29
Leverage ratio U.S.	87684	11.777	9.009	1.1	90.29
Leverage ratio Canada	425	15.846	21.094	1.1	90.29
LR Tier 1 constrained	753	3.410	3.899	1.1	84.65
LR Tier 1 constrained U.S.	639	3.068	2.540	1.1	53.67
LR Tier 1 constrained Canada	1	4.31	-	4.31	4.31
Capital stringency index	115150	6.842	0.6214	3	7
Non-performing loans ratio	94199	2.284	3.4095	0	18.64
Total assets	115150	5.711	1.762	2.398	11.658
Cost/income ratio	114762	70.359	20.055	25.79	170.97
Income diversity	113767	0.409	0.376	-0.222	2
Interbank ratio	35228	105.006	153.609	0	804.64
Liquid assets/dep & st. funding	113828	14.634	16.183	1.26	102.63
Loans/customer deposits	112441	83.770	33.266	12.28	246.31
Derivatives	40958	319.704	2335.671	0	21820.42
Off-balance sheet commitments	111456	474.608	2632.964	0	23477

The reported values refer to the transformed variables as the reported variables are yet winsorized at the 1% and 99% level to mitigate the impact of outliers, furthermore have the z-score and total assets already undergone a log transformation. Hence, these variables and associated values therefore have to be cautiously interpreted. In latter regressions, the lag (t-1) of all independent variables will be taken to mitigate concerns of reverse causality. In terms of interpreting the transformed variables, the adopted measure of the z-score tends

to overstate the stability of banks that have a high leverage ratio and understate the stability of those that have a low leverage ratio in comparison with the classic calculation of the z-score. Due to the fact that the leverage ratio is included as independent variable, it had to be eliminated from the calculation of the dependent variable. This over- or understatement therefore represents the difference between the bank's actual leverage ratio and the mean sample leverage ratio divided by the bank's standard deviation of return on assets. In addition are the variables z-score and total assets log-transformed. This entails that the coefficient of the log-transformed z-score can approximately be interpreted as the percentage change in the z-score resulting from a one unit change in the dependent variable.[23] All variables, except derivatives and the interbank ratio, are represented well in the sample. As derivative positions may be netted against each other in some countries, not all derivative positions entered by banks end up on their respective balance sheets, and hence, in our from Bankscope obtained sample. The leverage ratio, as can be derived from table 1, possesses a high standard deviation. Hence, although the mean leverage ratio is high above its regulatory minimum of around 5%, the individual scores fluctuate between 1- and 90 percent. It is furthermore noticeable that the mean leverage ratio is significantly higher in countries that impose a minimum leverage ratio requirement, providing some initial support for the thesis that a minimum leverage ratio secures higher bank capital ratios. These results are thereafter reversed when focusing solely on undercapitalized banks. Similar to the leverage ratio possess most employed variables a high standard deviation. The fact that different sorts of bank business models are included and that the balance sheet size differences between small and large banks can be significant large, gives rationale for such high in-sample standard deviation.

5.2 Effect of the leverage ratio on bank stability

Table 2 reports the estimated coefficients of the OLS regression analysis of the first hypothesis. The first specification assesses the impact of the leverage ratio

[23] See, e.g. Woolridge (2006).

on bank stability as measured by the z-score. In the latter specification is bank stability measured by the ratio of non-performing to gross loans.

Table 2
OLS regression H1

The table presents the parameter estimates from OLS regressions of model 1, $Z_{i,j,t} = \alpha + \beta 1\ LR_{i,j,t} + \beta 3\ controls_{i,j,t} + \varepsilon_{i,j,t}$. Dependent variable in the first specification is the z-score, and the ratio of non-performing loans in the latter specification. The first specification is furthermore estimated for a sub-sample of European, United States' and Canadian banks, respectively. All regressions are clustered on Bankscope index number, and country probability weights are additionally added. Year fixed effects denote whether these fixed effects are included in the regression model. The symbols *, **, and *** denote the statistical significance of the coefficients at the 10, 5, and 1 percent level, respectively. T-statistics are within brackets. The number of observations and the R^2 and adjusted R^2 of each regression can additionally be found in this table.

Variable	(1)	(1)	EU	US	Canada
Leverage ratio	0.00303	-0.0832***	0.0096*	0.00327	0.031
	[1.35]	[-4.06]	[2.33]	[1.39]	[0.80]
Total assets	-0.0412***	0.461***	-0.003	-0.0418***	0.0321
	[-7.00]	[10.87]	[-0.26]	[-6.95]	[0.10]
Cost/income ratio	-0.0144***	0.0601***	-0.0055***	-0.0145***	-0.0134**
	[-35.57]	[17.23]	[-6.22]	[-35.04]	[-4.03]
Income diversity	0.0508*	0.0105	0.0679	0.0514	-0.747*
	[1.97]	[0.04]	[1.42]	[1.95]	[-2.33]
Interbank ratio	-0.0000507	0.000414	0.0007	-0.0005	-0.0002
	[-1.17]	[1.47]	[1.14]	[-1.17]	[-0.31]
Liquid assets/dep. &	-0.00504***	0.0170*	0.00003	-0.0057***	0.0163*
st. funding	[-7.22]	[2.55]	[0.04]	[-7.34]	[2.25]
Loans/customer	-0.00289***	0.0252***	-0.0004	-0.0032***	0.00424
deposits	[-10.28]	[11.05]	[-1.42]	[-8.93]	[1.01]
Derivatives	0.0000087*	0.0000373	0.0000	0.00001*	-0.00004
	[2.04]	[1.35]	[0.15]	[2.10]	[-0.44]
Off-balance sheet	-0.0000128	-0.00013***	-0.0000	-0.0000	-0.0000
commitments	[-0.49]	[-6.47]	[-1.15]	[-0.16]	[-0.14]
Constant	3.621***	-8.425***	1.894***	2.839***	-1.166
	[27.80]	[-7.87]	[12.45]	[14.44]	[-0.20]
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	12080	11420	3447	8574	59
R-squared	0.309	0.187	0.212	0.311	0.606
adjusted R-squared	0.308	0.186	0.208	0.310	0.442

This table reveals that the leverage ratio does not have a significant impact on bank stability. Concerning the alternative measure of bank stability, the leverage ratio does have a significant impact on the ratio of non-performing to gross loans. More specifically, an increase in the leverage ratio of one standard deviation (9.382) will lead to a decrease in the ratio of non-performing to gross loans of 0.78 (9.382*-0.0832), approximately thirty percent of the mean value of the ratio of non-performing to gross loans. When the sample is disaggregated into banks from the European Union, Canada and the United States, it is noticeable that for European banks the leverage ratio does have a significant

impact on bank stability, i.e. a one standard deviation increase in the leverage ratio leads to an increase in the z-score of 0.09 (9.382*0.0096). Concerning the control variables, especially bank efficiency (i.e. cost/income ratio), funding (i.e. loans/customer deposits) and size (i.e. total assets) are significant, mostly at the 1% level. In conclusion is the first hypothesis, except for a subsample of solely banks from the European Union, rejected based on the first specification of bank stability. The first hypothesis is however supported based on the second specification of bank stability.

5.2.1 Country analysis

Table 3 reports the estimated coefficients of the OLS regression analysis of the second hypothesis. Although the model as specified in section 4.2 only assesses the impact of a combination of United States and Canada dummies, it is additionally chosen to include regressions that solely include a dummy for one of the two countries. In this way can differences between Canada and the United States be additionally assessed. The first specification includes, as can be deduced from table 3, solely a dummy for the United States, the latter specification solely includes a dummy for Canada and the last specification includes both dummies. The included dummies are used in interaction terms combined with the leverage ratio. The coefficients of the dummy variables in interaction terms with the leverage ratio, $\delta 1$ and $\delta 2$, therefore represent the extra effect of a one-unit change in the leverage ratio on bank stability for United States' and Canadian banks compared to European banks. It therefore increases the slope of the regressor predicting bank stability with the respective coefficient of the dummy variable.

Table 3
OLS regression H2

The table presents the parameter estimates from OLS regressions of model 2, $Z_{i,j,t} = \alpha + \beta 1\ LR_{i,j,t} + \delta 1\ US\ dummy * LR_{i,j,t} + \delta 2\ CA\ dummy * LR_{i,j,t} + \beta 3\ controls_{i,j,t} + \varepsilon_{i,j,t}$ .Dependent variable in the first specification is the z-score, and the ratio of non-performing to gross loans in the latter specification. United States is a dummy variable equaling 1 if the bank is from the United States and 0 otherwise. Likewise is Canada a dummy variable equaling 1 if the respective bank is from Canada and 0 otherwise. All regressions are clustered on Bankscope index number, and country probability weights are additionally added. Year fixed effects denote whether these fixed effects are included in the regression model. The symbols *, **, and *** denote the statistical significance of the coefficients at the 10, 5, and 1 percent level, respectively. T-statistics are within brackets. Additionally can the number of observations and the R^2 and adjusted R^2 of each regression be found in this table.

Variable	(2)		(2)		(2)	
Leverage ratio	0.0083*	0.224***	0.0030	-0.0832***	0.0083*	0.225***
	[2.04]	[6.29]	[1.34]	[-4.06]	[2.01]	[6.30]
United States	-0.0054	-0.311***			-0.00534	-0.312***
	[-1.50]	[-9.74]			[-1.47]	[-9.75]
Canada			0.0141	-0.453***	0.0096	-0.633***
			[0.99]	[-3.80]	[0.65]	[-5.99]
Total assets	-0.0412***	0.459***	-0.0412***	0.461***	-0.0412***	0.459***
	[7.01]	[10.80]	[-7.00]	[10.87]	[-7.01]	[10.80]
Cost/income ratio	-0.0144***	0.0601***	-0.0144***	0.0601***	-0.0144***	0.0601***
	[-35.57]	[17.19]	[-35.57]	[17.23]	[-35.57]	[17.19]
Income diversity	0.0497	-0.0454	0.0508*	0.0107	0.0497	-0.0453
	[1.92]	[-0.19]	[1.97]	[0.04]	[1.92]	[-0.18]
Interbank ratio	-0.0001	0.0003	-0.0001	0.0004	-0.0001	0.0002
	[-1.23]	[0.88]	[-1.17]	[1.47]	[-1.23]	[0.88]
Liquid assets/dep. & st. term funding	-0.0051***	0.0132	-0.0050***	0.0170*	-0.0051***	0.0131
	[-7.23]	[1.94]	[-7.22]	[2.55]	[-7.23]	[1.94]
Loans/customer deposits	-0.0030***	0.0207***	-0.0029***	0.0252***	-0.0030***	0.0207***
	[-9.47]	[8.16]	[-10.28]	[11.04]	[-9.46]	[8.15]
Derivatives	0.00001*	0.0000	0.0000*	0.0000	0.0000*	0.0001
	[2.08]	[1.70]	[2.04]	[1.37]	[2.07]	[1.73]
Off-balance sheet commitments	-0.0000	-0.0001***	-0.0000	-0.0001***	-0.0000	-0.0001
	[-0.44]	[-6.01]	[-0.49]	[-6.47]	[-0.44]	[-6.01]
Constant	3.611***	-9.015***	3.617***	-8.286***	3.609***	-8.823***
	[27.48]	[-9.34]	[27.67]	[-7.68]	[27.38]	[-9.09]
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12080	11420	12080	11420	12080	11420
R-squared	0.309	0.193	0.309	0.187	0.309	0.193
adjusted R-squared	0.308	0.192	0.308	0.186	0.308	0.192

This table shows that the extra effect of a one-unit change in the leverage ratio on bank stability as measured by the z-score for United States' and Canadian banks is, in all specifications, not significant. These results are in agreement with earlier findings, i.e. that the leverage ratio only has a significant impact on bank stability as measured by the z-score for a subset of solely European banks. The leverage ratio however has a significant impact on the ratio of non-performing to gross loans. This relationship is furthermore, in line with the stated hypothesis, significantly different for banks for the United States and Canada. Concerning the last specification, the economic significance of this coefficient will be that an increase of one standard deviation in the leverage ratio (9.382) will increase the ratio of non-performing to gross-loans with 2.11 (0.225*9.382). This relationship is entirely reversed for banks from the United States and Canada as an increase

of one standard deviation in the leverage ratio (9.382) will lead to a decrease in the ratio of non-performing to gross loans of 0.82 (0.225-0.312*9.382) in the United States and 3.83 (0.225-0.633*9.382) in Canada. The significance of the control variables and the variation in the dependent variable explained by the employed independent variables (R^2) are furthermore comparable to outcomes of the preceding regression. In conclusion is the second hypothesis rejected based on the first specification of bank stability, furthermore supported based on the second specification of bank stability.

5.3 Effect of capitalization on bank stability

Table 4 reports the estimated coefficients of the OLS regression analyses of models 3 and 4. In model 3 is the impact of undercapitalization (i.e. the Tier 1 capital ratio is below its regulatory threshold of six percent) on the bank capital-stability relationship assessed. In model 4 is it assessed whether this relationship is significantly different for undercapitalized banks from the United States and Canada. The dummy Tier 1 is combined in interaction terms with the leverage ratio. There is, as can be deduced from table 1, only one Canadian bank undercapitalized in the employed sample, subsequently are undercapitalized banks from the United States and Canada merged into one dummy variable, namely the dummy variable LR imposed. The coefficients of the dummy variables in interaction terms with the leverage ratio, δ3 and δ4, therefore represent the extra effect of a one-unit change in the leverage ratio on bank stability for undercapitalized banks and undercapitalized banks from the United States and Canada, respectively.

Table 4
OLS regression H3 & H4

The table presents the parameter estimates from OLS regressions of model 3, $Z_{i,j,t} = \alpha + \beta 1\ LR_{i,j,t} + \delta 3\ T1\ dummy * LR_{i,j,t} + \beta 3\ controls_{i,j,t} + \varepsilon_{i,j,t}$ and model 4, $Z_{i,j,t} = \alpha + \beta 1\ LR_{i,j,t} + \delta 4\ dummy\ LR\ imposed * LR_{i,j,t} + \delta 3\ T1\ dummy * LR_{i,j,t} * \delta 4\ dummy\ LR\ imposed + \beta 3\ controls_{i,j,t} + \varepsilon_{i,j,t}$. Dependent variable in the first specification is the z-score, and the ratio of non-performing to gross loans in the latter specification. Tier 1 constrained is a dummy variable equaling 1 if the bank's Tier 1 capital ratio is below its threshold of 6 percent 0 otherwise. LR imposed is a dummy variable equaling 1 if the bank is from the United States or Canada, and 0 otherwise. Therefore, if a bank is either not from the United States and Canada or/and not Tier 1 constrained, this dummy takes the value of 0. All regressions are clustered on Bankscope index number, and country probability weights are added. Year fixed effects denote whether these fixed effects are included in the regression model. The symbols *, **, and *** denote the statistical significance of the coefficients at the 10, 5, and 1 percent level, respectively. T-statistics are within brackets. Additionally, the number of observations and the R^2 and adjusted R^2 of each regression can be found in this table.

Variable	(3)		(4)	
Leverage ratio	0.00284	-0.0639***	0.0081*	0.244***
	[1.25]	[-3.33]	[1.97]	[6.90]
Leverage ratio LR imposed			-0.0053	-0.311***
			[-1.47]	[-9.71]
Tier 1 constrained	-0.0133	1.252***		
	[-0.68]	[4.56]		
*LR imposed*Tier 1 constrained*			-0.0134	1.337***
			[-0.62]	[4.41]
Total assets	-0.0411***	0.459***	-0.0412***	0.457***
	[-7.00]	[10.88]	[-7.01]	[10.84]
Cost/income ratio	-0.0144***	0.0569***	-0.0144***	0.0566***
	[-34.68]	[16.65]	[-34.56]	[16.52]
Income diversity	0.0506*	0.0371	0.0494	-0.0159
	[1.96]	[0.15]	[1.91]	[-0.07]
Interbank ratio	-0.0001	0.0004	-0.0001	0.0002
	[-1.17]	[1.44]	[-1.22]	[0.82]
Liquid assets/dep. & st. funding	-0.0050***	0.0169*	-0.0051***	0.0131
	[-7.22]	[2.56]	[-7.23]	[1.95]
Loans/customer deposits	-0.0029***	0.0250***	-0.0030***	0.0206***
	[-10.27]	[11.02]	[-9.46]	[8.19]
Derivatives	0.0000*	0.0000	0.0000*	0.0000
	[2.03]	[1.55]	[2.07]	[1.90]
Off-balance sheet commitments	-0.0000	-0.0001***	-0.0000	-0.0001***
	[-0.49]	[-6.54]	[-0.43]	[-6.10]
Constant	3.619***	-8.200***	3.611***	-8.693***
	[27.68]	[-7.80]	[27.51]	[-9.19]
Year fixed effects	Yes	Yes	Yes	Yes
Observations	12080	11420	12080	11420
R-squared	0.309	0.200	0.309	0.206
Adjusted R-squared	0.308	0.199	0.308	0.205

The results indicate that undercapitalization has a significant impact on the ratio of non-performing to gross loans, at a significance level of 1 percent. Although the leverage ratio significantly decreases the ratio of non-preforming to gross loans for adequately capitalized banks, an one standard deviation increase in the leverage ratio (9.382) will result in a 11.15 (-0.0639+1.252*9.382) increase in the ratio of non-performing to gross loans for undercapitalized banks, hence the third hypothesis is rejected. When a dummy variable is added for the United

States and Canada, it is noticeable that this relationship remains largely unchanged. More specifically, a one standard deviation increase in the leverage ratio will lead to an increase in the ratio of non-performing to gross loans of 12.29 (0.244-0.311+1.377*9.382) for banks which are undercapitalized and that are in addition from the United States or Canada. As the coefficient of the dummy is significant and furthermore leads to a significant larger increase in the ratio of non-performing to gross loans it can additionally be concluded that undercapitalization has a significant different impact on bank stability for banks from the United States and Canada, therefore supporting the fourth hypothesis. In conclusion are both hypotheses rejected when measuring bank stability by the z-score; both the regression coefficients are not significant. When measuring bank stability by the ratio of non-performing to gross loans these results reject the first hypothesis, as undercapitalization has a significant negative impact on bank stability as measured by the ratio of non-performing to gross loans. The results furthermore support the fourth hypothesis when bank stability is assessed by the ratio of non-performing to gross loans.

5.4 Effect of capital regulation stringency on bank stability

Table 5 reports the estimated coefficients of the OLS regression analysis of model 5. The specific per country scores on the capital stringency index can furthermore be found in table VI of the appendix.

Table 5
OLS regression H5

The table presents the parameter estimates from OLS regressions of model 5, $Z_{i,j,t} = \alpha + \beta 1\ LR_{i,j,t} + \beta 2 * CR_{j,t} * LR_{i,j,t} + \beta 3\ controls_{i,j,t} + \varepsilon_{i,j,t}$. Capital stringency represents an index which captures the level of capital regulation stringency, based on research of Barth et al. (2002). Dependent variable is the z-score in the first specification, and the ratio of non-performing loans in the latter specification. All regressions are clustered on Bankscope index number, and country probability weights are in addition added. Year fixed effects denote whether these fixed effects are included in the regression model. The symbols *, **, and *** denote the statistical significance of the coefficients at the 10, 5, and 1 percent level, respectively. T-statistics are within brackets. Additionally can the number of observations and the R^2 and adjusted R^2 of each regression be found in this table.

Variable	(5)	(5)
Leverage ratio	-0.0010	1.329***
	[-0.07]	[5.75]
Capital stringency	0.0006	-0.202***
	[0.31]	[-6.11]
Total assets	-0.0412***	0.459***
	[-7.00]	[10.80]
Cost/income ratio	-0.0144***	0.0601***
	[-35.38]	[17.21]
Income diversity	0.0509*	-0.0289
	[1.97]	[-0.12]
Interbank ratio	-0.0001	0.0003
	[-1.16]	[1.09]
Liquid assets/deposits & short-term funding	-0.0050***	0.0139*
	[-7.15]	[2.06]
Loans/customer deposits	-0.0029***	0.0223***
	[-9.82]	[9.18]
Derivatives	0.0000	0.0000
	[2.03]	[1.65]
Off-balance sheet commitments	-0.0000	-0.0001***
	[-0.49]	[-6.19]
Constant	3.622***	-8.565***
	[27.92]	[-7.75]
Year fixed effects	Yes	Yes
Observations	12080	11420
R-squared	0.309	0.192
Adjusted R-squared	0.308	0.190

Capital stringency does not have, as observable from table 5, a significant impact on bank stability as measured by the z-score. It however does have a significant impact on the ratio of non-performing to gross loans, therefore supporting the fifth hypothesis. As the capital stringency index is defined in interaction terms with the leverage ratio, these results imply that for the mean score on capital stringency (6.842), the leverage ratio has a negative impact on bank stability, namely -0.05 (1.329-0.202*6.842). As this index is however measured on a 0-7 interval, these results furthermore imply that capital stringency has a positive impact on bank stability, as measured by the ratio of non-performing to gross

loans, for a score of 7. The economic significance of these results is that for a score of 7 on the capital stringency index, a one standard deviation increase in the leverage ratio (9.382) will subsequently lead to a decrease of -0.80 (1.329-0.202*7,*9.382) in the ratio of non-performing to gross loans.

5.5 Robustness check

The sample consists, as can be derived from table II of the appendix, out of a variety of bank business models. To check whether previous findings are robust against the business model of banks, all regressions are furthermore performed on a sub-sample of solely commercial banks.

Table 5
OLS regressions Commercial banks

The table presents the parameter estimates from OLS regressions of models 1 to 5. United States is a dummy variable equaling 1 if the bank is from the United States and 0 otherwise. Likewise, Canada is a dummy variable equaling 1 if the bank is from Canada and 0 otherwise. Tier 1 constrained is a dummy variable equaling 1 if the bank's Tier 1 capital ratio is below its threshold of 6 percent 0 otherwise. LR imposed is a dummy variable equaling 1 if the bank is from the United States or Canada, and 0 otherwise.
Therefore, if a bank is either not from the United States/Canada or/and not Tier 1 constrained, this dummy takes the value of 0. Capital stringency represents an index, which captures the level of capital regulation stringency, based on research of Barth et al. (2002). Dependent variable in all specifications is the z-score. All regressions are clustered on Bankscope index number, and country probability weights are added. Year fixed effects denote whether these fixed effects are included in the regression model. The symbols *, **, and *** denote the statistical significance of the coefficients at the 10, 5, and 1 percent level, respectively. T-statistics are within brackets. Additionally, the number of observations and the R^2 and adjusted R^2 of each regression can be found in this table.

Variable	(1)	(2)	(3)	(4)	(5)
Leverage ratio	0.00273	0.0003	0.0026	-0.0001	-0.0060
	[1.17]	[0.05]	[1.10]	[-0.02]	[-0.35]
United States		0.0025			
		[0.54]			
Canada		0.0598***			
		[4.34]			
Tier 1 constrained			-0.0100		
			[-0.46]		
LR imposed				0.0027	
				[0.60]	
LR imposed*Tier 1 constrained				-0.0092	
				[-0.40]	
Capital stringency					0.0012
					[0.51]
Total assets	-0.0437***	-0.0437***	-0.0437***	-0.0437***	-0.0437***
	[-7.04]	[-7.03]	[-7.04]	[-7.03]	[-7.04]
Cost/income ratio	-0.0147***	-0.0147***	-0.0147***	-0.0147***	-0.0147***
	[-34.98]	[-34.98]	[-34.05]	[-33.98]	[-34.98]
Income diversity	0.0589*	0.0590*	0.0586*	0.0588*	0.0589*
	[2.16]	[2/16]	[2.15]	[2.15]	[2.16]
Interbank ratio	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000
	[-1.05]	[-1.05]	[-1.05]	[-1.04]	[-1.05]
Liquid assets/deposits & short-term funding	-0.0055***	-0.0055***	-0.0055***	-0.0055***	-0.0055***
	[-7.34]	[-7.26]	[-7.34]	[-7.26]	[-7.28]
Loans/customer deposits	-0.0032***	-0.0032***	-0.0032***	-0.0032***	-0.0032***
	[-8.93]	[-8.77]	[-8.92]	[-8.77]	[-8.83]
Derivatives	0.0000	0.0000	0.0000	0.0000	0.0000
	[1.64]	[1.62]	[1.64]	[1.64]	[1.64]
Off-balance sheet commitments	0.0000	0.0000	0.0000	0.0000	0.0000
	[0.21]	[0.20]	[0.21]	[0.20]	[0.20]
Constant	3.484***	3.484***	3.482***	3.493***	3.489***
	[35.53]	[37.52]	[35.50]	[37.57]	[36.43]
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	9643	9643	9643	9643	9643
R-squared	0.314	0.314	0.314	0.314	0.314
adjusted R-squared	0.313	0.313	0.313	0.313	0.313

When verifying the hypotheses on a subset of solely commercial banks, it is observable that the previously stated relationships remain largely unchanged; the leverage ratio does in neither specification have a significant impact on bank stability as defined by the z-score. Furthermore remain the previously inquired significance of several control variables largely unchanged when focusing solely

on commercial banks, albeit income diversity has a more significant impact on bank stability for commercial banks. It is additionally noticeable that, compared to the original regressions, the dummy variable for Canada in the second regression becomes significant. It is therefore concluded that the leverage ratio has a significant different impact on bank stability for Canadian banks, and this result is **not** robust for changes in business models that are employed in this thesis. It can nonetheless in general be concluded that the previously stated findings are robust to changes in the bank business model employed in this thesis.

6. Discussion

In this chapter are the results of the regressions carried out in this thesis interpret, furthermore are the findings compared with the theory and expectations mentioned in section 2.4. Bank stability is, as elaborated on in section 3, assessed by two indicators, i.e. the z-score and the ratio of non-performing to gross loans. Regarding the z-score, an increase in this measure is related to an increase in bank stability. Regarding the ratio of non-performing to gross-loans, a decrease in this measure is related to an increase in bank stability.

H1. The leverage ratio is positively related to bank stability.

Federal Reserve Chairman Ben Bernanke (2012) stated that: "Capital is important to banking organizations and the financial system because it acts as a financial cushion to absorb a firm's losses." If capital truly is essential to the stability of banks it seems straightforward to conclude that an increase in capital would subsequently lead to an increase in bank stability. The support for this hypothesis is however, as concluded in the preceding section, inconclusive. When measuring bank stability by the z-score, the leverage ratio does not have a significant impact on bank stability, although when disaggregated in sub-samples, this measure becomes significant for European banks. Furthermore has the leverage ratio a significant impact on bank stability when measured by the ratio of non-performing to gross loans. These inconclusive results are, albeit unanticipated, nonetheless in agreement with research of Berger et al. (1995)

who claim that the relationship between the balance sheet leverage ratio and bank safety is often relatively weak.

H2. The relation in H1 is significantly different for banks that are subject to a minimum leverage ratio requirement.

Concerning the second hypothesis, this hypothesis is rejected when bank stability is measured by the z-score. When bank stability is measured by the ratio of non-performing to gross loans the leverage ratio however not only has a significant impact on bank stability, this impact is furthermore significantly different for the United States and Canada, hence the second hypothesis is by this specification supported. In effect, it entails that an increase in the leverage ratio has a significantly more positive (i.e. negative slope) effect on bank stability for banks from the United States and Canada compared to banks from the European Union. These results therefore provide support for the main research question of this thesis, i.e. they indicate that capital has a more positive effect on bank stability in countries that impose a minimum leverage ratio requirement, albeit merely through an increase in the quality of the credit portfolio. The results furthermore indicate that this effect is significantly larger for Canadian banks compared to banks from the United States. This effect could be mitigated by the fact that the Canadian leverage ratio is regarded as a more comprehensive measure than that of the United States (Breuer, 2000). As the conservative lending of Canadian banks has been cited as one factor contributing to the strong performance of the Canadian financial sector during the financial crisis (IMF, 2009), could this difference additionally be explained by the risk-strategy that those banks adopted.

H3. The relation in H1 is more positive for banks that are undercapitalized, i.e. their Tier 1 capital ratio is below 6%.

This hypothesis is rejected in both specifications. The hypothesis is however rejected for the z-score based on insignificance of the coefficients, as opposed to the latter specification in which the leverage ratio, as well as undercapitalization, albeit significant move in the opposite direction of the stated expectations. The findings, as can be derived from table 4, indicate that undercapitalization has a negative mediating effect on bank stability. These findings contradict earlier

research of Heid et al. (2004), who find that banks with low capital buffers try to rebuild an appropriate capital buffer by raising capital while simultaneously lowering risk. These results provide support for the thesis that undercapitalized banks, as measured by Basel's Tier 1 capital ratio, increase risk when increasing capital, thereby negatively affecting bank stability.

H4. The relation in H3 is significantly different for banks that are subject to a minimum leverage ratio requirement.

Our findings support this hypothesis when bank stability is measured by the ratio of non-preforming to gross loans, however reject it when stability is measured by the z-score. Regarding the latter specification in table 4, it is observable that banks that are subject to a minimum leverage ratio requirement experience a significant more negative impact on bank stability. These findings are in line with the in section 2.4 expressed expectations. They furthermore provide additional support for the thesis of Kiema and Jokivuolle (2014), who advocate that the leverage ratio theoretically provides banks a risk-incentive when the leverage ratio is the binding constraint. It subsequently is indisputable that careful calibration of this requirement is essential for its effectiveness.

H5. The relation in H1 is stronger for banks in countries that possess more stringent capital regulation.

Referring to table 5, this hypothesis is rejected by the first specification and supported by the second specification. Hence, higher stringency of capital requirements, as measured by the capital stringency index (see Barth et al., 2004),[24] leads to a significantly lower ratio of non-performing to gross loans, albeit solely for a score of seven on the capital stringency index. As observable from table VI of the appendix have Canada and the United States, as well as most of the countries from the European Union, such maximum score of 7 on this index. These results confirm prior research of Barth et al. (2006) and Brewer et al. (2008), who find that capital promotes banking stability to a greater extent when capital regulation is more stringent. They furthermore indicate that there is

[24] Details on the specific calculation of the capital stringency index can be found in table I of the appendix.

a threshold below which the stringency of capital regulation adversely affects bank stability. As the United States and Canada on average score higher on the capital stringency index than countries from the European Union these results provide some indication that the stringency of capital regulation not only has a significant impact on bank stability, but additionally on the effectiveness of a minimum leverage ratio requirement.

Robustness check

The robustness check indicates that the additive effect of the leverage ratio on bank stability, as measured by the z-score, is significant for Canadian commercial banks. These results provide a base of support for the thesis that other aspects of the Canadian regulatory environment, i.e. the sound supervisory framework; stringency of the leverage ratio; and conservative lending practices, have contributed to the stability of the Canadian banking sector. These results could furthermore have provided Blundell-Wignall and Roulet (2013) justification for their claim that, "although a simple leverage ratio is essential, it cannot compensate for the large impact of business model features on banking stability."

Control variables

As control variables are additionally included in all regressions, it is interesting to have a look at findings on the control variables in addition to the key variables that were included and previously discussed in this thesis. In nearly all regressions have particularly control variables related to efficiency (i.e. the cost/income ratio), funding (i.e. loans/customer deposits), liquidity (liquid assets/deposits & short-term funding) and size (i.e. total assets) a significant impact on bank stability, measured by the z-score as well as the ratio of non-performing to gross loans. The forthcoming part will therefore elaborate on findings regarding these significant control variables. Size, as measured by total assets, has a significant negative impact on bank stability. Especially in light of the too-big-to-fail debate is this finding not surprising as large banks are provided an incentive to maximize risk due to the safety net provided by the TBTF support. Supporting this, Ayuso et al. (2004) offer evidence that larger banks hold lower levels of capital. Furthermore has efficiency, as measured by

the cost/income ratio, a significant positive impact on the stability of banks as well. As an increasing cost/income ratio is regarded as a sign of decreasing efficiency, these findings indicate that more efficiency will in addition lead to more stable banks. In addition has the funding structure, as measured by the ratio of loans to customer deposits, a significant negative impact on the stability of banks. This indicates that if customer deposits are increasingly replaced by short-term wholesale funding, this will have a negative impact on bank stability. These findings are in line with research of Ratnovski and Huang (2009), who advocate that the funding structure of banks has a large impact on the stability of banks. Lastly has liquidity, as measured by the ratio of liquid assets to depository and short-term funding, a significant positive impact on the stability of banks. This measure indicates that if liquid assets are less funded by liquid liabilities, thereby increasing the liquidity gap, this will negatively affect bank stability.[25] This result is not surprising; insufficient liquidity has been cited as a major contributor to banking instability. The outcomes furthermore provide a base of support for newly taken regulatory initiatives that address liquidity, such as Basel III's liquidity coverage ratio. In conclusion it can be stated that the size, efficiency, funding and liquidity of banks have a significant impact on bank stability. Moreover indicate the findings that bank stability is not significantly affected by the diversity of bank income, as well as market discipline (i.e. the interbank ratio). The results additionally provide some inconclusive evidence that bank stability might be positively affected by the use of derivatives and off-balance sheet commitments, notwithstanding the fact that the coefficients on these variables are small and most often insignificant.

7. Conclusion

The first section of this chapter gives a summary of the findings presented throughout this thesis. Thereafter are in section 7.2 the practical and theoretical implications of this thesis presented. In section 7.3 are the limitations of this

[25] For an explanation of the liquidity gap see e.g. Cornett and Saunders (2011).

thesis documented and thereafter section 7.4 concludes with recommendations for further research.

7.1 Conclusion

The main objective of this thesis was to determine the impact of a minimum leverage ratio requirement on the capital-stability relationship in the banking sector. In order to do so, a set of hypotheses was developed to examine this effect and to analyze whether the capitalization of banks, as well as other aspects of capital regulation, affected inquired relationships. Employing five regression models and multiple specifications using bank observations from 2003 to 2013 from 27 countries, these effects where thereafter empirically tested. When studying the effect of capital on stability in multiple regressions, our results provide inconclusive evidence. The impact of capital on bank stability as measured by the z-score is in nearly all regressions insignificant. The impact of capital on bank stability as measured by the ratio of non-performing to gross loans is on the contrary significant in nearly all regressions. This is an indication that the benefits of the leverage ratio mainly come from an increase in the quality of the credit portfolio, as opposed to a reduction in the volatility of returns (i.e. risk). And as advocated by Beck (2008) measures the ratio of nonperforming loans credit risk and is not related to the likelihood of failure.

It is therefore concluded that the leverage ratio has contributed to bank stability in the United States and Canada in the sense that it enhances bank stability by lowering the credit risk of the portfolios bank hold, hence by enhancing the asset side of the balance sheet. It however does not have a significant impact on the overall stability of banks. It is believed that the grey area in between largely consists out of the measurement of leverage (i.e. economic-, embedded- and balance-sheet leverage). This is in line with reasoning of D'Hulster (2009), who advocates that the leverage ratio not properly reflects trends in financial innovation as significant leverage is assumed through economic and embedded leverage. There is additionally provided support for that the calibration of the leverage ratio is essential to the effectiveness of this measure, as well as the definition of capital at risk. The findings furthermore indicate that the funding of banks has a significant impact on bank stability. The obtained diverging results

regarding the different measures of bank stability could therefore be reflective of a discrepancy in stability effect on the asset and liability side of the balance sheet. This could have provided Blundell-Wignall and Roulet (2013) justification for their claims as they advocate that: "although a simple leverage ratio is essential, it cannot compensate for the large impact of business model features on banking stability."

7.2 Practical implications

The findings of this thesis contribute to the existing literature because there yet is limited research on the effect of minimum capital requirements already in place on bank stability. It is however challenging to empirically assess the impact of a minimum leverage ratio requirement, for reasons on which will be elaborated on in section 7.3. These results therefore merely give an indication of the relationship between a minimum leverage ratio requirement and bank stability. The results indicate that, although the minimum leverage ratio requirement can provide benefits, there are other features of regulatory policy that are moreover important. The results furthermore indicate that the leverage ratio has a negative impact on bank stability when being the binding measure for banks, subsequently is careful calibration of this requirement essential for it's effectiveness. There is in addition offered evidence concerning the impact of included control variables on bank stability. Concerning policy recommendations can rationale for new regulatory proposals be additionally found in the findings of this thesis. For example findings on size as well as funding structure give ground for the often cited importance of liquidity as well as the currently heavily debated separation of banking activities, which is according to Blundell-Wignall and Roulet (2013) essential for bank stability.[26] These results furthermore add to the growing body of evidence that the impact of the funding structure of banks on banking stability is beyond doubt significant.

[26] Since December 2013 such measure is adopted in the U.S. The Volcker rule, part of the Dodd-Frank Wall Street Reform and Consumer Protection Act, bans proprietary trading, and prohibits commercial banks to sponsor or invest in hedge- or private equity funds by means of own accounts.

7.3 Limitations

Most prevalent limitation of this thesis stems from the fact that the leverage ratio, as most regulation, is gradually phased in. As these transition periods are often long, and furthermore accompanied by all sorts of transition agreements, an event study in any kind on the impact of a minimum leverage ratio requirement on bank stability is empirically impossible. As not being subject to a minimum leverage ratio requirement does not translate into a balance sheet leverage ratio of zero, is it furthermore empirically challenging to verify the main research question of this thesis. The obtained results are therefore, although it is believed that this thesis has provided some additional insight, merely an indication of the relationship between a minimum leverage ratio requirement and bank stability. Another limitation of this thesis stems from the fact that practically every facet concerned with banking is complex, especially complexity and differences in capital regulation (Basel III by itself already has numerous implementation choices), accounting methods and bank's on- and off-balance sheet activities make any research on banking challenging. And although I have, by writing this thesis, gained much valued knowledge about the financial and regulatory environment in which banks nowadays operate, it remains challenging to obtain a full grasp of the complex relationship between bank capital and stability.

7.4 Recommendations

There is still a wide scope for improvement and further research. On a practical level, the coverage of the sample can be extended to a larger number of countries and banks, furthermore could some of the data gaps in Bankscope be filled using other data sources. The data could in addition be harmonized to account for differences in accounting practices. Although time-consuming, it could largely benefit the empirical grounds on which the regulatory bank capital-stability relationship is assessed. On a theoretical level will the upcoming decade provide an interesting playfield in which to further research the impact of a minimum leverage ratio requirement on bank stability as this requirement, being part of the Basel III regulatory framework, will be gradually phased in. For better or worse, the financial and regulatory environment is going through a significant

transition and entering a new chapter. And the outcomes in terms of bank stability, resilience and new financial innovations introduced will all hopefully lead to a more coherent view on in which manner financial institutions should be regulated to benefit society most.

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Appendix

Table I
Regulatory capital index

This table represents the questions and calculations of the regulatory indices, as composed by Barth et al. (2002)

Variable	*Definition*	*Quantification*	*World Bank Survey IV Questions*
Overall Capital Stringency	Whether the capital requirements reflect certain risk elements and deducts certain market value losses from capital before minimum capital adequacy is determined.	(Higher values indicate greater stringency) Yes = 1 No = 0 3.1(a)+3.2(a)+3.2(b)+ 3.18.3(d)*3+1 (if 3.18.2<.75)	3.1 Which regulatory capital adequacy regimes did you use as of end of 2010 and for which banks does each regime apply to (if using more than one regime)? a. Basel II 3.2 Which risks are covered by the current regulatory minimum capital requirements in jour jurisdiction? a. Credit risk b. Market risk
Initial Capital Stringency	Whether certain funds may be used to initially capitalize a bank and whether they are officially.	(Higher values indicate greater stringency.) For question 1.4.2: Yes = 1 No = 0 For question 1.4.3 and 1.5: Yes = 0 No = 1 1.4.2+1.4.3+1.5	3.18.2 What fraction of revaluation gains is allowed as part of capital? 3.18.3 Are the following items deducted from regulatory capital? d. Unrealized gains 1.4.2 Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities? 1.4.3 Can the initial disbursement or subsequent injections of capital be done with assets other than cash or government securities? 1.5 Can initial capital contributions by prospective shareholders be in the form of borrowed funds?
Capital Regulatory Index	Sum of (IV.I) + (IV.II)	(Higher values indicate greater stringency) Sum of (IV.I)+(IV.III)	

Table II
Bank business models

This table represents the business models of banks included in the sample, per country.

	BHC	Commercial Bank	Cooperative Bank	Investment Bank	Real Estate Bank	Savings Bank
Austria	6	51	78	2	10	55
Bulgaria	0	12	1	0	0	1
Canada	5	32	8	5	0	0
Croatia	0	21	1	0	0	1
Cyprus	1	6	2	1	0	1
Denmark	1	29	2	0	8	19
Estonia	0	4	0	1	0	0
Finland	1	6	1	0	2	2
France	1	83	48	6	14	16
Germany	4	72	939	14	27	415
Greece	1	9	1	1	0	0
Hungary	0	17	0	2	3	0
Ireland	0	7	0	6	2	0
Italy	4	51	358	7	1	30
Latvia	0	12	0	0	0	0
Lithuania	0	5	0	0	0	0
Luxembourg	2	45	2	1	0	0
Malta	0	3	1	3	0	1
Netherlands	7	13	1	0	3	0
Poland	1	17	1	0	0	1
Portugal	2	11	0	3	0	2
Romania	0	18	0	0	0	1
Slovakia	1	7	0	0	0	1
Slovenia	0	10	1	0	0	0
Spain	0	15	54	3	0	12
United Kingdom	22	79	0	40	41	0
United States	944	6519	9	11	16	727
Total	1003	7154	1508	106	127	1285

Table III
Variables employed

This table represents an overview of all the dependent and independent variables used, elaborates on their calculation, source and which concept it measures.

VARIABLE	MEASURE	CALCULATION	SOURCE
Z-SCORE	Bank stability	ROA / σ ROA	Bankscope
NPL	Bank stability	NPL / Gross Loans	Bankscope
LR	Leverage ratio	Total Equity/ Total Assets	Bankscope
CAP REG	Capital regulation stringency index	See table 1	Barth, Caprio & Levine (2008)
TA	Total assets	Log Total Assets	Bankscope
ID	Income diversity	1 –(NII- OID)/OI	Bankscope
C/I	Cost/income ratio	Operating expenses/income	Bankscope
LA/DSF	Liquid assets/ Deposits & short-term funding	Liquid assets/deposits	Bankscope
OBS	Off-balance sheet commitments	Balance sheet item	Bankscope
DER	Derivatives	Balance sheet item	Bankscope
IBR	Interbank ratio	Money lent to other banks/ money borrowed	Bankscope
I	Inflation		World bank
GDP	Growth gross domestic product	$GDP_t - GDP_{t-1}$	World bank
GGL	Growth gross loans	$Gross\ Loans_t - Gross\ Loans_{t-1}$	Bankscope
LOANS/CD	Loans/ Customer deposits	Total loans/ total customer deposits	Bankscope

Table IV
Variance Inflation Factors

This table represents the VIF's of all variables. Threshold is 5 with tolerance of 0.2

Variable	VIF	1/VIF
Leverage ratio	1.07	0.931638
Total assets	1.82	0.549086
Cost/income	1.08	0.923267
Growth gross loans	1.05	0.952852
Interbank ratio	1.06	0.942161
Income diversity	1.23	0.812793
Liquid assets/Dep. & st. funding	1.24	0.080911
Loans/Customer deposits	1.42	0.704291
Off-balance sheet commitments	2.07	0.484193
Derivatives	4.97	0.201386
~~Deposits from banks~~	5.68	0.176144
~~Inflation~~	221.34	0.004518
~~GDP~~	362.75	0.002757

Table V
Pairwise correlation matrix

This table contains pairwise correlation coefficients of the variables that are used in this study

	Z-SCORE	NPL	LR	TA	C/I	ID	IBR	LA/DSF	LOANS/CD	DER	OBS
Z-SCORE	1										
NPL	-0.404	1									
LR	-0.081	-0.066	1								
TA	-0.013	0.1994	-0.246	1							
C/I	-0.425	0.1817	0.0666	-0.214	1						
ID	-0.028	0.0900	0.2885	0.3217	-0.002	1					
IBR	-0.031	0.1151	0.0518	-0.041	0.0156	0.0737	1				
LA/DSF	-0.113	0.1015	0.2727	0.093	0.0915	0.320	0.3430	1			
LOANS/CD	-0.117	0.2260	-0.071	0.3350	-0.095	0.0763	-0.121	-0.128	1		
DER	-0.039	0.0157	-0.100	0.4125	-0.033	0.2113	0.0292	0.3031	0.1287	1	
OBS	-0.040	0.0409	-0.018	0.4640	-0.069	0.1999	-0.021	0.1321	0.1559	0.4557	1

Table VI
Capital regulation index scores

This table presents individual scores on measures of capital regulation stringency, as proposed by Barth et al. (2002), where higher values indicate greater capital regulation stringency. Details on the specific construction of the indices can be found in table I. The measures are calculated based on data obtained from the database of the corresponding paper "Bank Regulation and Supervision in 180 countries from 1999 to 2011" of Barth et al. (2013).

Country	Overall capital stringency	Initial capital stringency	Capital regulatory index
Austria	4	2	6
Bulgaria	7	3	10
Canada	7	1	8
Croatia	7	2	9
Cyprus	6	3	9
Denmark	4	1	5
Estonia	7	3	10
Finland	7	1	8
France	7	2	9
Germany	7	2	9
Greece	7	1	8
Hungary	3	2	5
Ireland	7	1	8
Italy	6	1	7
Latvia	7	3	10
Lithuania	6	2	8
Luxembourg	7	2	9
Malta	7	1	8
Netherlands	7	2	9
Poland	7	2	9
Portugal	4	2	6
Romania	7	2	9
Slovakia	6	1	7
Slovenia	6	2	8
Spain	7	2	9
United Kingdom	4	1	5
United States	7	1	8