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The impact of capital regulations

A study of the Basel framework

by

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Abstract

Financial crises are a major issue in modern history. In a great deal of the financial crises there is a banking crisis involved. To regulate and supervise banks the Basel framework was created. With the framework, the aim is to enhance financial stability and to minimize the effect from a potential financial crisis. This paper aims to investigate if banks have changed their behavior since the new capital requirements were introduced and to discuss the possible macroeconomic effects. To accomplish this, the analysis is divided into two parts. First, banks' balance sheets in Germany, Italy, Sweden, the United Kingdom and the United States are investigated from January 2003 to January 2019, with a focus on the share of housing loans to total assets and loans to non-financial corporates to total assets. The development of the variables are examined and tested for structural breaks with multiple breakpoint test. Second, the results are analysed with the background from the framework, financial crises and systemic risk to discuss possible macroeconomic effects. The findings of the paper are that it is not possible to find structural changes in the variables, share of housing loans to total assets and loans to non-financial corporates to total assets, directly connected to the implementation of Basel. However, it is possible to observe a trend that banks have changed their behavior during the period. Banks tend to allocate their assets towards assets that require a lower level of capital, such as housing loans. This could imply that banks are more dependent on the housing market to stay stable. On the other hand, the regulations are more comprehensive than they have been before.

Keywords: the Basel framework, Macroeconomic, financial crises, systemic risk, multiple breakpoint test

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Abbreviations

<i>Abbreviation</i>	<i>Definition</i>
BCBS	Basel Committee on Banking supervision
ECB	European Central Bank
FED	Federal Reserve
CET1	Common Equity Tier 1
HQLA	High Quality liquid asset
IRB	Internal ratings based
LTV	Loan to value
NFC	Non-financial corporates
RWA	Risk-weighted assets

1 Introduction

Throughout the 20th and the beginning of the 21st century, one of the world's major issues has been financial crises. The consequences of the two most famous crises, the Great Depression and the financial crisis in 2007-2008, have been substantial for financial systems, with mass unemployment and a significant drop in economic activity as two examples. In these financial crises, banks play a crucial part. During the latest global financial crisis in 2007-2008, banks were arguably one of the actors to blame the most for the severe outcome of the subprime mortgage crisis (Fратиanni & Marchionne, 2009). Banks are considered to be special and not ordinary corporations. Thedéen (2016), highlights two aspects regarding banks' balance sheets that make them vulnerable, which might affect the entire economy. First, banks have liquid debt and illiquid assets. This implies that crucial parts of their financing may change quickly. Second, in comparison to industrial firms, banks hold a low level of capital, which creates a sensitivity to external shocks. The two aspects make banks vulnerable and create a need for regulations of banks, to increase the stability and decrease the risk of a bank to default.

In order to stabilise the banking sector the Basel committee, an international collaboration between 11 countries, was created in 1974 (BCBS = Basel Committee of Banking Supervision, 2018a). Since then, they have continuously worked towards enhancing financial stability through capital regulation and supervision. Plenty of studies has investigated how the Basel regulations affect the economy. Researchers have for instance identified the benefits and costs from the regulations, the optimal level of regulations (Almenberg et al., 2017; Riksbanken, 2011; Hall et al., 2012) and how banks can adjust to meet the new requirements (Cohen & Scatigna, 2016). However, most of the studies are done by observing the effect from Basel on different macroeconomic variables, such as the fluctuations and the level of GDP, or by doing experiments where different levels of capital are tested. There is not a great deal of studies that discuss the banks' adjustment to Basel and how the new conditions may affect the economy.

Therefore this thesis strives to contribute to the field with an approach that focuses on how the lending practices have changed. This thesis aims to investigate how the implementation of the Basel regulations affects banks' behavior and how a possible change in the behavior may affect

the risk for a financial crisis. In order to accomplish this, the development of banks' balance sheets will be investigated with a focus on the variables: share of housing loans to total assets and the share of loans to non-financial corporates (NFC) to total assets. The following countries will be used: Germany, Italy, Sweden, the United Kingdom, and the United States during the period from January 2003 to January 2019. The development of the variables will be analysed from graphs and multiple breakpoint tests to find structural breaks in banks' behavior.

From the tests, no direct connection between the implementation of the Basel regulation and the change in banks' behavior was found. This was observed through changes in the structure of banks' balance sheets. However, there was a trend for banks to allocate their assets towards loans to housing, which in general requires a lower level of capital compared with other loans. This implies that banks have adjusted to the regulations, but not directly as the implementation was introduced. Another implication from this is that banks may be more dependent on the housing market to stay stable.

This thesis consists of five parts. The first chapter refers to problems from systemic risk and how financial crises in general develop. The second chapter is regarding how the Basel framework has developed throughout time and its construction. The third chapter highlights effects of the framework that other researchers have found. The fourth chapter describes the method that is used in this thesis. The fifth chapter consists of the analysis.

2 Banks and financial crises

2.1 Systemic risk

In a world where countries and their monetary financial institutions get more and more interconnected with each other, the concept of systemic risk is analysed more than ever. IMF, BIS, and FSB (2009) define the concept of systemic risk as when an institution malfunctions or goes bankrupt creates widespread distress, either directly or as a start of a contagion. This can be seen through the disturbance of flow within financial services, which may lead to severe consequences for the economy. The definition of systemic risk applies to the financial crisis in 2007-2008. Then the trigger was the malfunction of Lehman Brothers. This created the domino effect which harmed other financial institutions and in the end caused the financial crisis (De Haas & Van Horen, 2012).

In terms of systemic risk, Schwerter (2011) summarises the concept as banks focusing on their survival rather than the entire financial sector's wellbeing. This creates a negative externality through the banks that participate. With the possible externality, there is a need to regulate the systemic risk to avoid market failure. Here Schwerter emphasizes the importance that a bank's failure needs to be internalized; without it, there is risk banks take on excessive risk. This is problematic for primarily three reasons: i) numerous banks are too big to fail, ii) banks are too interconnected with each other, with assets and interbank loans, and iii) banks might be too many to fail. If several banks start to malfunction simultaneously, there are incentives for central banks to bail them out. If just one or a few banks fail, there might be other banks that may acquire them. This creates a moral hazard (Acharya & Yorulmazer, 2007). Either one of these would imply critical consequences for the economy if it would occur.

Connected to the three concerns above are the cross-sectional and time dimensions (Schwerter, 2011). The cross-sectional dimensions refer to the structure of the financial system. If a bank malfunctions, it may cause a domino effect and contagion other financial institutions which may affect the entire financial system. The time dimension treats the development of aggregate risk.

During the peak of a business cycle, the level of debt increases (Reinhart & Rogoff, 2008). A higher level of debt makes the banks vulnerable. Due to this, Borio (2003) emphasizes the importance of dampening the fluctuations of business cycles to reduce the systemic risk.

In addition to Borio, within systemic risk three kinds of areas are often discussed: contagion risk, macroeconomic shocks and the risk of imbalances getting exposed that has been growing slowly over some time (ECB = European Central Bank, 2009). The first risk refers to when one bank's failure spreads to another bank that seemed to be solvent, but due to the level of interdependence, the second bank might fail as well. The second risk could be an economic downfall through defaults in credit. This would presumably affect several banks at the same time. The third risk is built up over time, similar to Borio's (2003) view on business cycles. For instance, a lending boom to finance consumption or investment (ECB, 2009). Here a small shock might lead to a quick change in the value of the asset. That may affect the financial system in a widespread manner and affect several banks at the same time. Two of the underlying factors to the imbalances growing over time are the herd behavior and the low interest rates. The first factor implies that investors tend to invest in similar assets, which causes them to create similar risks (Banerjee, 1992). The second factor refers to an increasing risk-taking connected with the low interest rates. From the three primary areas of risk (ECB, 2009), there may be some overlapping, and they may cause each other. In particular, the first and second risks are closely connected.

2.2 The making of a financial crisis

From systemic risk the connection to financial crises is not farfetched. During the last century there are numerous cases when banks collapsed, which created widespread distress and affected the entire economy and in the end caused a financial crisis.

Financial crises are not a new phenomenon, yet the phrase "this time is different" (Reinhart & Rogoff, 2009) is commonly used within the area. However, most of the financial crises in history share a similar timeline. Reinhart and Rogoff (2008) examine 18 financial crises with a special banking focus in modern history. Five out of these crises had a more substantial impact than the rest: Spain in 1977, Norway in 1987, Finland in 1991, Sweden in 1991, and Japan in 1992, these are denoted as the big five. In addition to this, the study highlights the financial

crisis in 2007-2008. The study observes the three variables that are most frequently used in literature regarding financial crises: asset prices, public debt, and economic growth. Reinhart and Rogoff (2008) conclude that the 18 financial crises in their selection show the same pattern. In general, asset prices peak just before the crisis occurs, and the public debt is increasing rapidly. This makes the banks vulnerable and exposed to a high level of risk. Together with the systemic risk, an external shock could be devastating. As a consequence of the crisis, economic growth decreases significantly, and it takes roughly 3-4 years before it returns to its trend level. The financial crisis in 2007-2008 follows this general pattern as well. Figure 1 shows the development in housing prices and public debt four years prior to a financial crisis begins and three years after. To the left, it is possible to see that even though the crisis in 2007-2008 stood out, it followed the same trend as the average banking crisis, it was no different.

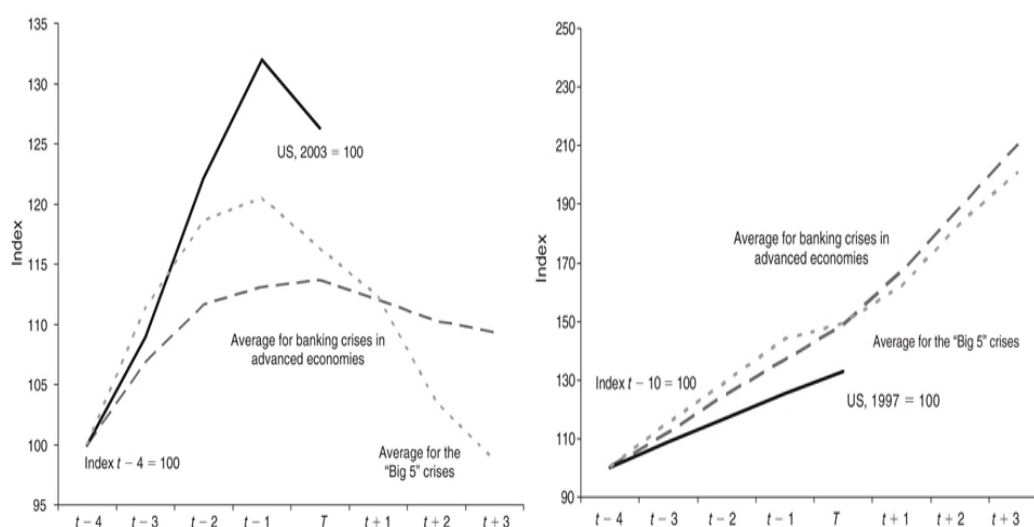


Figure 1. The development of housing prices and public debt before and after financial crises.
Source: Reinhart and Rogoff, 2008.

Kaminsky and Reinhart (1999) also study financial crises. However, their study focus on the underlying factor for both banking and currency crisis. The selection of countries includes both developing and developed countries. Their findings imply that financial liberalization plays an essential part in banking crises. They use the example of increasing access to international financial markets to explain how it works. The increasing opportunities for financing may boost the already ongoing peak in the economy. This might cause an increased vulnerability for the economy through increasing asset prices and debt, which may lead to a financial crisis. Similar to Reinhart and Rogoff (2008) timeline of an average financial crisis. Kaminsky and Reinhart (1999) point out that this is more likely to occur with a fragile banking sector than with a more

stable one. To conclude, they emphasize the need for banking regulations and supervision to decrease the risk of a financial crisis. With regulations, the banking sector will become more stable, and the risk for systemic risk will decrease.

The timeline of the financial crisis in 2007-2008 is an event that is well documented, Hausman and Johnston (2014), for example, examines the underlying factor for the crisis in 2007-2008. They focus on five contributing factors: Housing, debt, commodity markets, financial innovations, and declining wealth. These factors go well in line with the other studies with a more general approach, both Reinhart and Rogoff (2008) and Kaminsky and Reinhart (1999) examine similar factors. For instance, in all three studies, the asset prices play a crucial role, Hausman and Johnston (2014) describe the origin of the crisis from the loans to costumers with a questionable credit level. When the price for housing declined, people started to default on their loans and made the American housing market to collapse, which caused the banks to shiver one by one. This domino effect is an excellent example of systemic risk, where Lehman Brothers eventually collapsed, partly due to their dependence on the housing market, and their downfall had a significant impact on the entire financial sector. The development went hand-in-hand with the financial innovations as well, with credit swaps and mortgage-based securities as two examples, this created an incorrect assessment of the risk level. The part with financial innovations could be compared with Kaminsky and Reinhart (1999) focus on financial liberalization. Hausman and Johnston (2014) write about an over-investment in financial markets which created the foundation of financial bubbles. This is similar to Kaminsky and Reinhart (1999) study with increasing financing opportunities and increasing vulnerability.

Furthermore, the financial crisis did not stay just in the United States. With international capital markets getting increasingly more open during the end of the 20th century, foreign lending increased significantly in the United States (Mendoza & Quadrini, 2009). This meant that the financial crisis could spread globally when the American housing market plummeted, partly due to the increased interdependence between financial institutions from different countries. Going back to the timeline of 2007-2008 (Hausman and Johnston 2014), the result is common knowledge. Lehman Brothers declared bankruptcy in September 2008 when the Fed decided not to bail them out. They did not have the tools to handle the financial difficulties. Their malfunctions then created a ripple effect through the connected financial institutions, and the entire system was affected.

To sum up, the main problem with systemic risk is how the contagion spreads from one bank towards other banks. This aggravates the situation significantly. Closely connected to systemic risk is financial crises, which can be derived from two main components: a drop in asset prices and a high level of debt. If asset prices decrease rapidly during a period with a high level of debt, banks are vulnerable. Then, if one bank would collapse, it could harm the entire system. This is why there is a clear need to regulate banks.

3 Construction of The Basel regulation

The Basel regulation is a set of rules for banks regarding capital requirement, supervision, and disclosure, created by the Basel Committee. The regulations aim to enhance financial stability and to create a forum for cooperation (BCBS, 2018b). Today, the structure and aim of the regulations are different from in the beginning. The development has occurred as a response to empirical experiences, as numerous financial crises. From the financial crises, a demand for changes in the previous regulation emerged. This designed the current framework, in order to avoid past mistakes. Today the committee consists of 45 members from 28 countries, see Appendix A, (BCBS, 2016). The members are central banks and other institutions that have a responsibility for the supervision of banks. For instance, Sweden has two members, the central bank (Riksbanken) and Sweden's financial supervisory authority (Finansinspektionen).

3.1 The development of Basel

The Basel framework has developed to deal with systemic risk as a response to various financial crises and events. In the beginning of the 1970s, there was a period with an ongoing financial concern. For instance, the oil crisis in 1973, which had a global impact. The year after, the West German bank, Herstatt, failed (BCBS, 2018a). As a result, the Group of Ten¹, G10, created the Basel Committee. The primary goal was then to increase financial stability through the improved supervision of banks worldwide. In 1975, the first report regarding supervision was released. This was the first step from an unregulated financial sector towards a more regulated.

¹ Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States (BCBS, n.d.)

The next step evolved from the debt crisis in Latin America in the beginning of the 1980s (BCBS, 2018a). Together with a trend where major international banks' capital ratios declined, there was a need for the committee to respond. In 1988 the committee released the Basel Capital Accord, or Basel I. Four years later it was implemented. The new regulations included a minimum capital to risk-weighted assets of 8 percent. With the introduction of risk-weighted assets, the Basel Committee's focus now included capital requirements in order to work for financial stability.

During the 1990s, there was another period with financial disturbance. For instance, there were financial crises in Sweden and the United Kingdom in 1991, and in 1992 in Japan (Reinart & Rogoff, 2008). This created the demand for further regulations to secure a more stable financial sector. In 2004 the next framework was released, Basel II (BCBS, 2004). The new framework was much more comprehensive than its predecessor. It can be divided into three different pillars. The first pillar refers to capital requirement. The second pillar to the supervision process, including risk management and transparency. The third pillar covers market discipline, which includes disclosure requirements for banks. While Basel I had a definite implementation date (BCBS, 2018b), Basel II had different implementation phases in different countries. However, three years after Basel II was released the financial crisis of 2007-2008 begun.

In the aftermath of the financial crisis the demand for an improved framework increased, and in 2010 an updated framework was released. From 2013 until the end of 2019 it is being implemented. The updated framework included tighter capital requirements, special requirements for systemically important banks, and the possibility to use countercyclical measures (BCBS, 2018a). The measure towards systemically important banks could be connected to the default of Lehman Brothers. A similar event is something the Basel Committee aims to avoid. The possibility to use countercyclical measures refers to times when the debt level grows rapidly, as it often does in the making of a financial crisis.

3.2 The Basel framework

The Basel framework is today divided into three different parts, or pillars. Table 1 shows a summary of what each pillar includes. The first pillar refers to capital requirements. It consists of how much capital banks are required to have for different levels of capital and during

different scenarios. The second pillar refers to risk management and supervision. This pillar focuses on four key principles: capital adequacy, banks' internal strategies, the fluctuations of the market and the need of a higher level of capital and lastly the supervisor's role and what the role has for authority over the banks. The third pillar entails disclosure requirements for the banks. This state how, when, and where banks are required to publish their reports over their level of risk to uphold transparency.

Table 1. A summary of the three pillars.

	Pillar I	Pillar II	Pillar III
Summary	Capital requirements:	Supervisory review process:	Disclosure requirements:
	- Minimum regulations	- The four key principles	- Transparency
	- Evaluate risk-weight	- Supervisor's role	- Structure over reports
	- Countercyclical buffers		

Source: BCBS 2019a, BCBS 2019b, BCBS 2019c

The first pillar: Capital regulations

In response to financial risks and crises, the capital regulations have evolved to its current structure. Within the Basel framework there are several specific rules for different scenarios. Table 2 shows the most important regulations the framework is based on. To understand the table some of the components need to be defined. Common equity tier 1 (CET1), tier 1 capital, and tier 2 are three different definitions of capital. CET1 is most narrow and consists mainly of common shares, stock surplus, retained earnings, and other accumulated income that fulfil the criteria for CET1. Tier 1 capital consists of CET1, but has a broader criterion for the components, which makes it larger than CET1. Tier 2 capital consists of instruments that are issued by the banks and do not meet the criteria for tier 1, the connecting stock surplus to the instruments, revaluation of assets, and loan-loss provisions. Total capital is the sum of tier 1 and tier 2 capital (BCBS, 2019d). The risk-weighted assets (RWA) states the amount of the assets that have a higher risk. Some assets have 0 percent risk, while others have 70 percent. The total RWA is calculated as the risk-weight times the value of the asset (BCBS, 2019a). The exposure measure is the sum of four exposures: on-balance sheet, derivative exposures, securities financing transaction, and off-balance sheet items. High-quality liquid asset (HQLA) is defined as assets, or cash, that can be sold fast and converted into cash without a decrease in value (BCBS, 2019c).

Table 2. Capital and liquidity requirements

Ratio		Min. requirement
CET1 of risk-weight asset (RWA)	$\frac{CET1}{RWA}$	> 4.5 %
Tier 1 capital of RWA	$\frac{Tier\ 1\ capital}{RWA}$	> 6 %
Total capital of RWA	$\frac{Total\ capital}{RWA}$	> 8 %
Leverage ratio	$\frac{Tier\ 1\ Capital}{Exposure\ measure}$	> 3 %
Liquidity ratio	$\frac{HQLA}{Net\ cash\ outflow\ over\ the\ next\ 30\ days}$	> 100 %

Source: BCBS 2019a, BCBS 2019b, BCBS 2019c

In addition to the minimum requirement, each member jurisdiction of the Basel has the authority to use countercyclical buffers (BCBS, 2019e). For instance, if a central bank observes an increasing growth rate in debt, they have the opportunity to increase the required level of capital between 0 to 2.5 percent. The countercyclical buffers may be for a specific bank or a geographic area.

The next aspect to consider is how the risk weight is measured. Depending on what kind of asset and how it is structured, the level of risk differs. Within the Basel regulations there is plenty of specific rules for different assets and different structures of the assets. This paper will focus on residential real estate and credit risk to corporates. To measure risk there are two different approaches: Internal ratings-based (IRB) and standard approach. The first approach is based on the banks' internal ratings. For a bank to be able to use the IRB approach it must get the approval from their supervisor and show that their system fulfils the requirements. The system should include five variables: probability of default, loss at default, exposure at default, maturity, and a risk weight. Depending on how the variables are calculated a risk weight will be created as a result. In general, loans to housing results in a lower risk weight than loans to corporates (BCBS, 2019f).

The standard approach differs significantly. For credit risk an external actor gives the loan a rating (BCBS, 2017a). Loans with the rating AAA to AA- has the lowest risk weight, with 20 percent. If the rating is below B- the risk weight is 150 percent. In total there are five different risk groups. There is also a difference if the exposure is short term, where the risk weight is lower if the credit is on short term compared with long term. For loans to residential real estate

the component loan to value (LTV), i.e. the percentage of the property's value that is financed through a loan, states the risk weight. For instance, if the loan of the real estate is lower than 50 percent of the property's value the risk weight is 20 percent, while if the LTV is between 90 to 100 percent the risk weight is 50 percent (BCBS, 2017a).

Depending on which system is used, the level of risk weight differs. The IRB approach gives a significantly lower risk weight. For instance, the median risk weight while using the IRB approach is 34 percent for banks in the European Union. The same number when using the standard approach is 75 percent (Turk-Ariss, 2017). In regards to which asset of housing loans and loans to corporates that require the lowest amount of capital, it is housing. The risk weight for housing loans differs from 6 percent to 31 percent for European banks. For corporates the risk weights differ from 32 percent to 84 percent, in both examples the IRB approach is used.

The second pillar: Risk management and supervision

The second pillar states how banks should work with risk. It also includes a framework for the supervisors. The supervisory process consists of four key principles (BCBS, 2019g). The first principle refers to banks' process for capital adequacy. This has five main areas: board and senior management oversight, sound capital assessment, comprehensive assessment of risks, monitoring and reporting, and lastly internal control review. Within these areas, there are rules and guidelines on how the banks should work with the capital adequacy. For instance, the area with board and senior management oversight state the importance of the boards' knowledge of the capital requirement when creating a strategic plan for the firm.

The second key principle focuses on the supervisor's role when reviewing and evaluating the banks' work with capital requirements and their systems for calculating risks. The supervisor needs to make sure the banks' capital level is correct in the aspect of their level of risk, that the senior management fulfils their responsibilities and that the structure of the capital is composed in a relevant and secure way. One of the aspects is whether the risk is diversified or not.

The third key principle refers to the fluctuations in the overall capital ratio. Due to this, banks are encouraged to operate above the minimum level of the required capital. With external shocks there is a risk of losing capital or that the capital structures changes. If banks do not meet the required level of capital, they will become subject to the supervisors' intervention.

The fourth key principle states what measures the supervisor is entitled to use if a bank does not follow the capital regulations. For instance, the supervisor has the right to restrict the level of dividends, to increase the monitoring of the bank and to require the bank to increase the level of capital immediately.

The four key principles in the second pillar are the foundations of ensuring the first pillar is followed. In the second pillar, the way the banks should work to be able to enforce the regulations is stated. Without them, there is a clear risk that the capital regulations will not be followed.

The third pillar: Market discipline

The third pillar, market discipline, the Basel regulations aim to reach through disclosure requirements. This means that the banks will be more transparent and publish reports regarding their financial status. With this, the third pillar aims to reduce the level of asymmetric information and make it easier to compare banks' different risk profiles. How these reports are reported is clearly stated in several points. For instance, the reports need to be posted parallel to the financial report for the period, it must also be posted in a standalone document, they should be consistent over time, and they should be comparable between different banks (BCBS, 2019h).

What the content of the reports should be is also stated in the third pillar. Depending on which asset it is, there is a template for the banks to use available (BCBS, 2017b). For instance, the templates for credit risk includes the quality of credit risk, changes compared with the previous period, and mitigation of risk (BCBS, 2015). To keep the trust in the financial market it is crucial to be transparent. With the third pillar banks are given the tools to increase transparency.

To sum up the framework, the first pillar focus on capital regulation, which states how much capital banks are required to have concerning their level of risk-weighted assets. It also includes how different assets are measured and that there are two approaches, IRB and standard, to measure risk. The second pillar refers to risk management and supervision. It states how banks should work with risk and what the supervisor has the authority to do. The last pillar is regarding disclosure requirements for banks. This states how the bank should work to maintain transparency.

3.3 Criticism of the Basel framework

From the substantial analysis of Basel, some criticism has evolved, primarily regarding the rating system (Doeme & Kerbl, 2018). In the ratings there is a significant difference in the outcome if the internal rating based (IRB) approach or the standard approach is used. There is also a difference in how the IRB approach is used between different countries and banks. When calibrating the different variables, such as probability of default or exposure at default, banks might use different methods, which might cause a different risk weight for the assets. This implies that it could be difficult to compare the risk level between different banks.

The complexity in the regulations could also be observed in numerous banks that underreport their level of risk (Begley et al., 2017). With the underreporting the requirement for capital decreases, which is beneficial for banks. Since the banks own assessments have a significant impact on their required level of capital, they have incentives to underreport their risk-weighted assets. One of the reasons this occurs even though banks are supervised is believed to be due to banks complex business models. They can make it challenging to analyse the banks' risk level easily, and there is a fear the supervisors become undermined. In conclusion, to get an entirely correct level of the banks' risk level could be tricky.

The problem with banks' incentives to underreport their risk-weighted assets and the complexity of the framework is not taken lightly. One of the possible solutions that is discussed and where future research is requested is to make the framework simpler. Studies have shown that simple rules could perform better than more complex rules (Ingves, 2016). The idea with more straightforward rules is based upon it should be easier for banks to follow them, which could increase the incentives for enforcement.

4 Literature on the effects from Basel

The effects from the capital and supervision regulations from the framework of the Basel committee has been the foundation of a great deal of research ever since it was introduced in 1992. With the development of Basel, the research has shifted to focus more on capital regulation, rather than the supervision. Today the literature can be divided into four fields: optimal regulation, adjustment channels for banks, the risk of a banking crisis, and the cost of the regulations.

The first part, optimal regulation, investigates on which level the capital regulations maximize welfare. Almenberg et al. (2017), for example, studies the social cost and benefits in terms of a higher level of capital requirements. The costs are the negative effect on GDP, and the benefits are the decrease in the risk of a banking crisis. They find that the optimal capital ratio should be 5-12 percent of the bank's total assets. However, their ratio should not be confused with the measure including RWA. Riksbanken (2011) comes to a slightly different conclusion. They state that the optimal total capital ratio should be around 10-17 percent of the risk-weighted assets. Almenberg et al. (2017) refers to the study from 2012 and argue that the ratio from 2012 could be even higher, due to a belief that the social cost during a financial crisis is underestimated. Nevertheless, even with the capital ratio from the study by Riksbanken (2011), it would be on a higher level than the 8 percent required today. The idea with a higher capital regulation is supported by Hall et al. (2012), which focus on the United Kingdom. Their findings state that the optimal common equity tier 1 (CET1) of the risk-weighted assets should be 10 percent, significantly higher than the minimum requirement of 4.5 percent. These three studies (Almenberg et al., 2017; Riksbanken, 2011; Hall et al., 2012) all state that the optimal capital regulations should be higher than the current level from the society's perspective. Nevertheless, even with the current regulation, banks need to adjust to fulfil the requirements.

In terms of channels of adjustments to meet the capital, four different methods are commonly discussed (Cohen & Scatigna, 2016). The first strategy is through increasing the bank's retained earnings. Either by reducing the share of the profit they pay out in dividends, or by increasing profits. One of the easiest way to accomplish that would be to increase the lending spread.

However, in a competitive market it might be challenging to increase the lending spread successfully. The second strategy is for banks to issue new equity. This is considered to be one of the least tempting alternatives since this would likely decrease the market value of the existing shares. The third adjustment channel is for banks to adjust their assets on the balance sheet, for instance, by selling assets or by decreasing the lending growth. The fourth strategy implies that banks can reduce their level of risk-weighted assets and increase their level of assets with a lower risk level. This would lower the required level of capital. The strategy that is found to be the most common used for banks to follow the capital regulation, in both advanced and in emerging economies, is to adjust through the accumulation of retained earnings to reach the required capital level (Cohen & Scatigna, 2016). The second most observed adjustment channel is for banks to change their share of risk-weighted assets towards a higher share of assets with a lower risk. This behaviour is primarily observed in advanced economies.

After the banks have adjusted to the capital requirements, the goal with the regulations is to have a more stable financial market and to reduce the risk of a banking crisis. The decrease in risk for a banking crisis is a common factor in several studies. The findings imply that with a higher level of capital, the risk of a bank crisis decreases, which might not be too surprising (Almenberg et al., 2017; Dermine, 2015). With a higher capital ratio the risk of a bank to default decreases, but the effect is diminishing. A second aspect that is investigated is the possible consequences of diversification of assets (Dermine, 2015). Through banks' internal rating system there exists a capital relief if banks diversify their assets. This could actually lead to an enhanced risk for the banks. There are studies (Dermine, 2015) that imply that the diversification does not equal the lower level of required capital in terms of risk assessment.

In regards to the cost of the Basel framework, the most analysed aspect is economic activity. Slovik and Cournéde (2011), for example, examines the impact on GDP and lending spreads from a higher capital requirement. With a higher lending spread the economic activity will decrease in the short run, through an increase in the cost of investment, this will decrease the growth in GDP. Angelini et al. (2015) do a similar study on economic performance by experimenting with different levels of the required capital. Their findings imply that a one percentage point increase in capital requirement causes a 0.09 percentage point decrease in the level of steady-state growth output. A third study is done by Allen et al. (2012). Their findings are in line with the two former and can summarise the research area. In the short run, there is

an imminent risk economic activity will be negatively affected, but in the long run the effect will most likely disappear.

To sum up, the Basel framework has an impact on the economy and banks. The positive consequence for the economy is the decrease in the risk for a banking crisis, while the adverse effect is a possible decrease in economic activity. The impact on banks can be observed through the channel of adjustment, where the two most observed strategies are to adjust through increased retained earnings and to decrease the level of risk-weighted assets.

5 Data & Methodology

This paper aims to investigate if the banks have changed their behavior since the capital regulations were introduced and to discuss possible macroeconomic effects. My study is divided into two parts to accomplish this.

5.1 Method

First, I investigate banks' aggregate balance sheets in five countries: Germany, Italy, Sweden, the United Kingdom, and the United States, and test whether the Basel framework has caused any changes in lending practices. The analysis is performed by observing the development of loans to housing and three categories of loans to non-financial corporates (NFC), where the maturity time differs. First, the development is analysed in light of the Basel framework by investigating the graphs of the variables. Second, multiple breakpoint tests are performed to find structural breaks, i.e. differences in the estimation of the regression (Chow, 1960), in the data. The tests are based on a multiple linear regression, which includes the dependent variable (y_t), a constant (β), a trend term (δ_j) and an error term (u_t):

$$y_t = z'_t \beta + x'_t \delta_j + u_t$$

The regression is then tested for an unknown number, l , breaks (Bai & Perron, 1998). First, it is tested if there is a structural break at all, by testing if the null hypothesis is $\delta_0 = \delta_1$. If the null is rejected, then it takes the next step, and test if there are one or two structural breaks. This process is repeated sequentially until there are no more structural breaks, or if the highest number of allowed breakpoint is reached. The tests are performed by F-tests to find the number of breakpoints that minimize the sum of squared residuals. One of the advantages of the test is that it allows for serial correlation in the error terms and that it is robust to heteroscedasticity (Bai & Perron, 1998). Another advantage from the setup is that it show how and when banks have changed their behavior in terms of lending practices. However, there are some limitations from the multiple breakpoint tests. The result will show when structural breaks occur. Then it

will be possible to connect the results to specific years of a higher significance, as when the framework was released or implemented. One disadvantage is that it might be difficult to tell the actual reason behind the change. The development of the banking sector is everchanging. Due to this it might be other aspects that affect banks' behavior in addition to the new regulations. To understand the underlying factors better one method could be to interview people in charge of banks' strategical plan, but due to limitations in resources this was not possible in this study. Nevertheless, the implementation of the Basel framework affects banks' business significantly. Therefore it is reasonable to believe that banks will adjust to it.

The second part of the study analyses and discusses how the changes in the asset structure may affect the economy. The analysis will use the foundation from the framework of Basel, how a financial crisis is made, and systemic risk to accomplish this part.

5.2 Descriptive statistics

Table 3 shows the descriptive statistics for the variables. This analysis is based on monthly data collected from the European Central Bank (2019) for the four European countries and from the Federal Reserve System (2019) for the United States. The period that is investigated is from January 2003, with Sweden and the United Kingdom going beyond this date, to January 2019. For all variables, it is the share of total assets that is analysed. For instance, table 3 shows that in Germany the share of total assets that consists of housing loans for aggregate banks is in average 13.4 percent, the lowest observed value is 11.1 percent, while the highest is 15.8 percent.

In three out of the four European countries, housing loans have the highest mean of the four variables. However, in Italy, the highest mean is found for the loans to non-financial corporates (NFC) with a maturity length over five years. Overall, Italy's four means are closer to each other in comparison to the other countries. For example, Sweden's mean for housing loans and loans to NFC over five years differs significantly with 0.198, respectively 0.015. The average share of housing loans on the balance sheet in Sweden, 0.198, is the highest among the European countries.

Table 3. Descriptive statistics

Loans to Housing	Obs.	Mean	Std. Dev	Min	Max
Germany	193	0.134	0.011	0.111	0.158
Italy	193	0.085	0.010	0.062	0.103
Sweden	207	0.198	0.018	0.157	0.249
United Kingdom	217	0.132	0.017	0.092	0.162
United States ²	193	0.290	0.033	0.240	0.345

Loans to NFC < 1 year	Obs.	Mean	Std. Dev	Min	Max
Germany	193	0.021	0.004	0.017	0.034
Italy	193	0.088	0.017	0.060	0.126
Sweden	207	0.130	0.009	0.110	0.150
United Kingdom	217	0.018	0.002	0.015	0.022

Loans to NFC 1-5 years	Obs.	Mean	Std. Dev	Min	Max
Germany	193	0.017	0.002	0.013	0.021
Italy	193	0.043	0.009	0.031	0.061
Sweden	207	0.040	0.015	0.026	0.078
United Kingdom	217	0.006	0.001	0.005	0.007

Loans to NFC > 5 years	Obs.	Mean	Std. Dev	Min	Max
Germany	193	0.079	0.005	0.071	0.093
Italy	193	0.095	0.007	0.077	0.110
Sweden	207	0.015	0.011	0.006	0.039
United Kingdom	217	0.036	0.004	0.031	0.044

All loans to NFC	Obs.	Mean	Std. Dev	Min	Max
Germany	193	0.118	0.006	0.104	0.134
Italy	193	0.226	0.023	0.187	0.263
Sweden	207	0.185	0.027	0.145	0.261
United Kingdom	217	0.060	0.007	0.051	0.073
United States	193	0.063	0.008	0.050	0.093

² Loans to all real estate and not just residential real estate.

6 Analysis

The first step in this analysis is to investigate the development of the variables. Figures 2, 3, and 4 show how the variables have responded to the financial crisis in 2007-2008 and the capital regulations. Figure 2 shows that there is a trend for banks to increase the share of total assets towards housing loans. All of the four European countries have their highest share of loans to housing at the end of the period, with Sweden as the country which displays the highest share with approximately 25 percent. It is also possible to observe the aftermath of the financial crisis in 2007-2008, with a decrease in the share of the total assets that consisted of housing loans. However, after the crisis there is a clear trend towards an increasing share of housing loans for the four European countries. Figure 3 shows the development of the United States share of real estate to total assets. There the peak occurred before the financial crisis and it is yet to recover to the same level, but since 2015 it shows an increasing trend.

The implementation phase of Basel II differed between countries, but the years after it was released, in 2004, there was a negative trend for Germany and the United Kingdom, while Italy and Sweden displayed a positive trend when focusing on housing. However, to state that Basel II is the reason for the decrease is problematic. The trend occurs just before the financial crisis in 2007. The years before financial crises are in general special and are believed to have a significant impact (Reinart & Rogoff, 2008).

For Basel III the implementation phase reaches from 2013 to the end of 2019. Again, it is difficult to connect the development of housing loans to the updated framework. For both Germany and the United Kingdom there is an upward going trend, but for the United Kingdom the trend starts already in 2009. For Sweden, there is an increase in the share as well. Here it is a rapid increase between 2009 and 2011 before the increasing trend fades out to fluctuate about 21 percent until the end of the period when there are signs of a new increasing trend. For Italy, it is possible to observe an ongoing positive trend from the start of the period until the end, with some exceptions during the financial crisis. However, even though the four countries show a positive trend towards the share of housing loans to total assets overall, the development is difficult to connect directly to the implementation of Basel. Nevertheless, the development is

in line with how banks could react to the new framework. There are incentives to change their lending practices towards housing since it requires a lower level of capital. To maximize profit, banks aim to not hold more capital than necessary. This could imply that banks have adjusted accordingly to the Basel framework, but not direct when the framework was being implemented. One of the reasons for this might be due to it takes time for banks to adjust to the updated framework. To reallocate assets is not something that can be done quickly. For instance, parts of the banks business are contracts and loans that go on for several years.

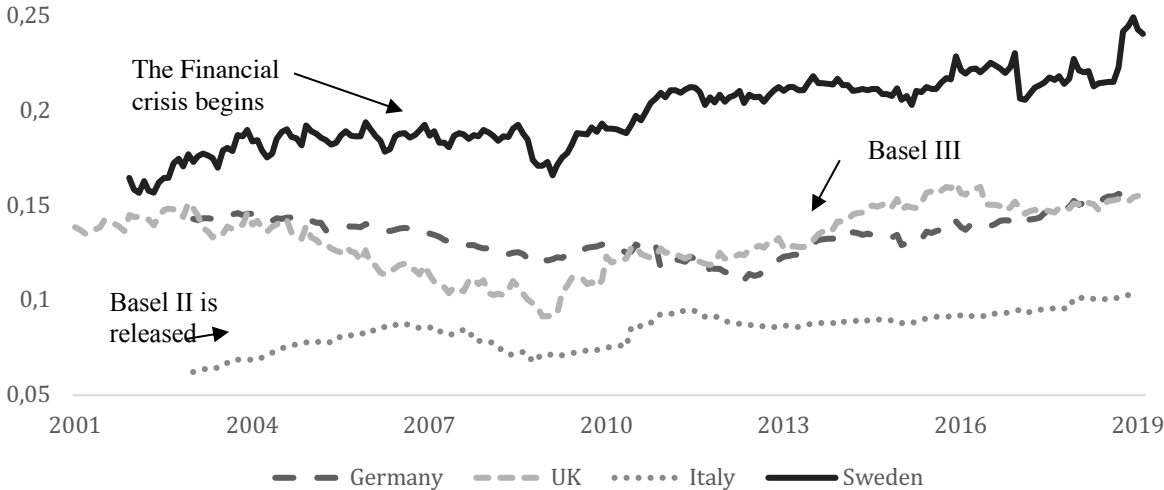


Figure 2. Share of housing loans to total assets

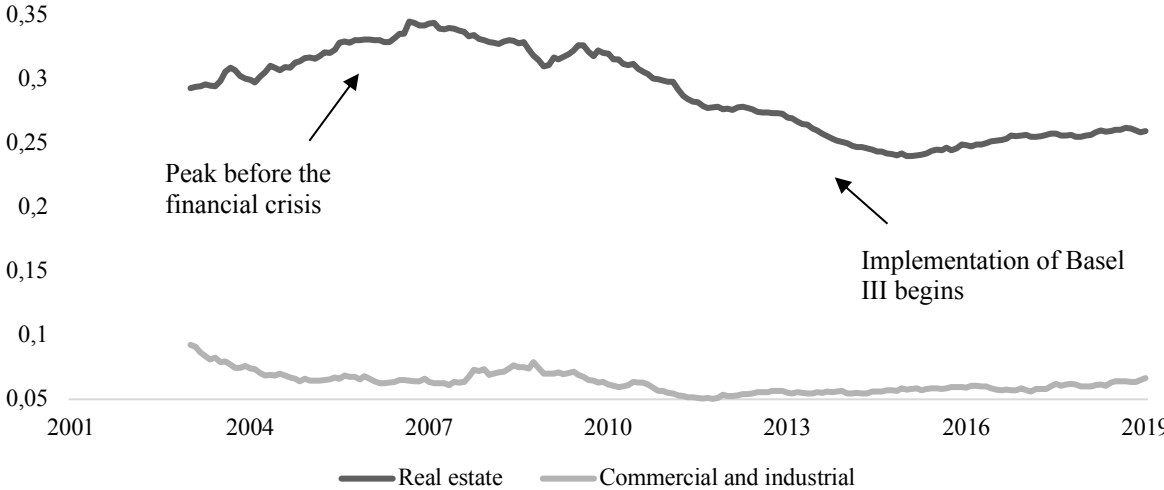


Figure 3. Loans to real estate of total assets and to commercial and industrial loans of total assets in the United States.

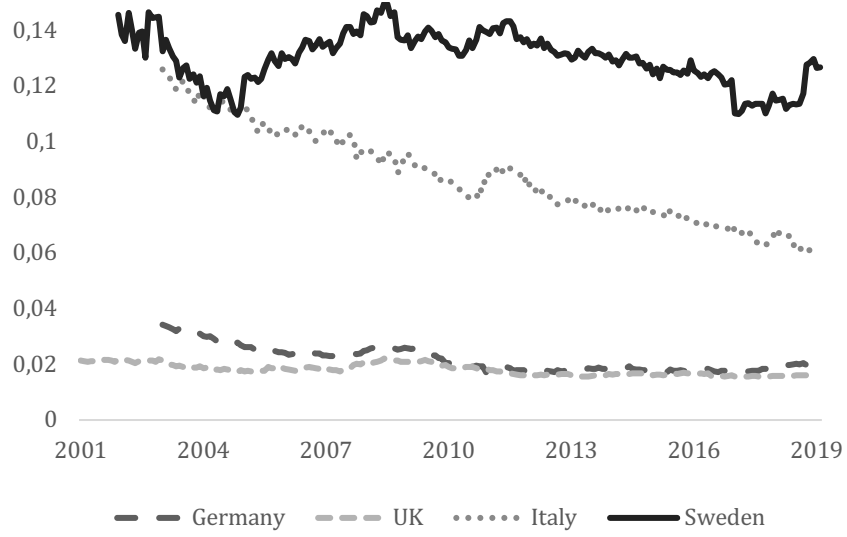
For the United States, see figure 3, the story differs compared to the four European countries. There is a positive trend after the implementation of Basel III begun, but the share of real estate

to total assets is significantly lower than during the buildup to the financial crisis. One of the possible reasons for this might be that the consequences of the financial crisis are still fresh in mind, where the real estate market played a crucial role. This might cause American banks to be careful not to focus too much of their assets towards real estate.

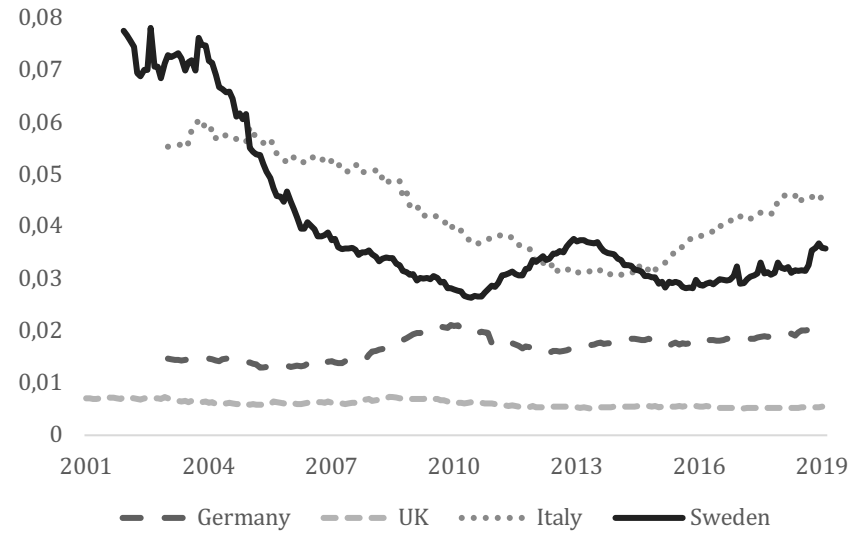
For the share of loans to non-financial corporates (NFC) to total assets, there is a different development compared to the loans to housing to total assets. Figure 4 shows that for both Germany and the United Kingdom, the levels have not changed particularly much for any of the maturities. The same goes for the United States, see figure 3, since 2005 the share of commercial and industrial loans to total assets has been approximately 6 percent each year. This is not the case for Italy and Sweden. For loans to NFC with a maturity of less than a year, the Swedish value fluctuates around the mean on 13 percent. For Italy, there is a clear downward sloping trend during the entire period, with an initial value of 12 percent and the final value of 6 percent. The figure also shows that both Italy and Sweden have a negative trend for loans to NFC over a medium-term until 2010 when the variables stabilise and then fluctuates on the same level. The last variable, loans to NFC for a maturity time for over five years, do not show any clear trends.

In terms of the implementation of the frameworks it is not possible to see any apparent changes as a result from the implementation neither for Basel II after 2004, nor for Basel III after 2013 for any of the variables or countries. However, it is possible to observe in panel d that both Italy and Sweden have a lower share of loans to NFC to total assets at the end of the period compared with their respective initial value.

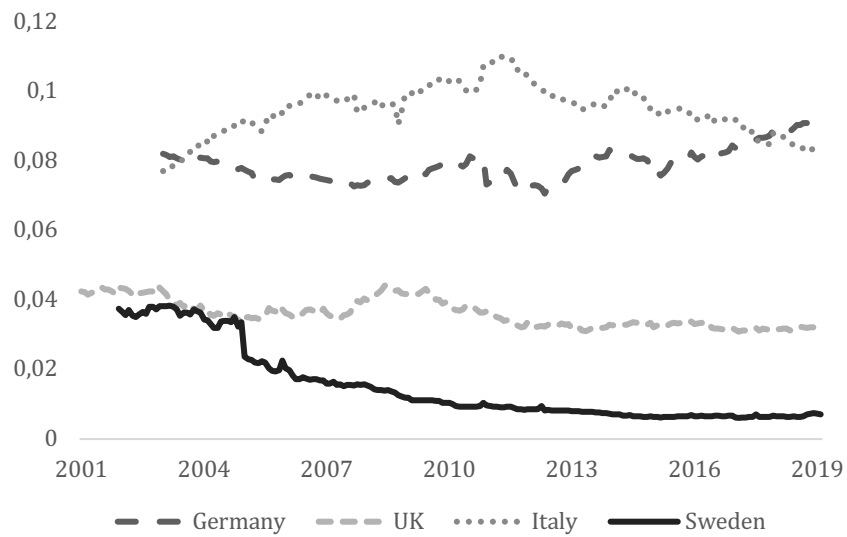
To sum up, it is possible to observe that banks have changed their behavior during the first part of the 21st century, see figures 2, 3, and 4. Figure 2 shows that in the beginning of 2019 all four European countries' banks have a higher share of housing loans to total assets compared with their initial value. In figure 4 panel d it is possible to observe changes in banks' structure concerning loans to NFC, mainly for Italy and Sweden. This implies that banks tend to focus more on assets with a lower risk weight, in particular Sweden. However, it is difficult to connect the changes in behavior directly to the implementation of the Basel framework.



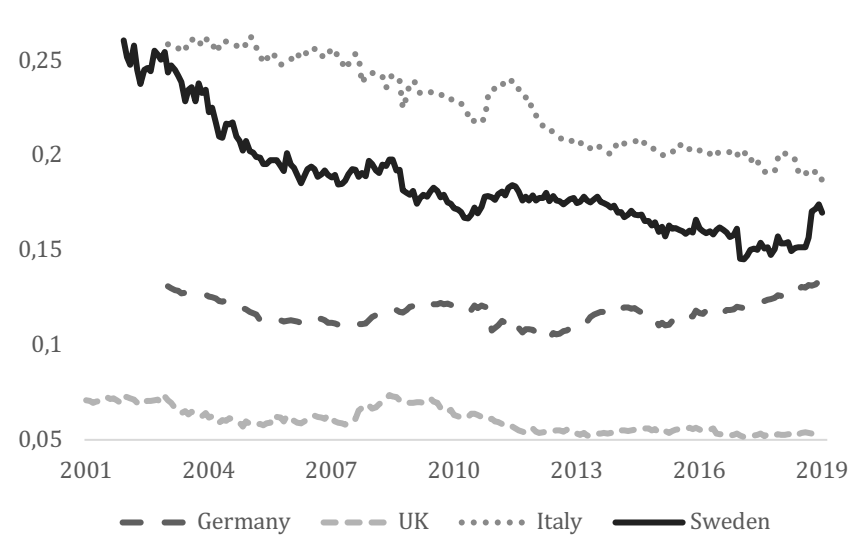
Panel a: Loans to NFC < 1 year



Panel b: Loans to NFC 1-5 years



Panel c: Loans to NFC > 5 years



Panel d: All loans to NFC

Figure 4. Share of non-financial corporates (NFC) to total assets

Multiple breakpoint tests

The result from the breakpoint test is displayed in table 4, the months that are included in the table are all significant breakpoints on the 0.05 level. Before the tests, a regression including the testing variable, a constant and a trend has been performed. The months that are displayed in table 4 indicate that a structural break has occurred that month. From table 5, where the results are summarized by the year the breakpoint occurred, five years deviate with a higher amount of structural breaks: 2005, 2007, 2010, 2011, and 2016. Going back to the making of a financial crisis and figure 1, it is typical for a financial crisis to affect some years before the financial crisis, and a few years after the peak of the crisis. This could be the case with the four first years that stands out with a higher amount of breakpoints. Even though the focus in figure 1 is on price and debt level, it is reasonable to assume that it has an impact on the share of housing loans to total assets and the share of loans to NFC to total assets as well.

In terms of the implementation of the Basel framework, the multiple breakpoint tests do not detect any year closely connect to the updated framework that stands out. For instance, in 2013, when Basel III began its implementation phase. This implies that banks have not directly changed their behavior connected to the implementation of the Basel framework. The results are in line with the discussion from the graphs above. Nevertheless, there might be an indirect, slower, effect of Basel. The graphs in the figures 2, 3, and 4 show that banks have moved their assets towards assets with a lower risk, as housing loans are compared to loans to NFC (Turk-Ariss, 2017). This is also one of the adjustment channels that is commonly discussed (Cohen & Scatigna, 2016).

Connected to the result is, of course, the choice of method. Some limitations need to be taken into consideration. One of the difficulties is to distinguish the origin of the changed behavior. From the tests, it is not possible to conclude with certainty what caused the changes. However, it is possible to observe a change in banks' behavior that goes in line with previous studies. This implies that even though it might not be possible to say precisely when banks have adjusted to Basel, there are clear signs that they have adjusted.

To conclude the first part of the aim, after investigating the graphs and the results from the multiple breakpoint tests, there is no significant direct connection between banks behavior and the first implementation phase of the capital regulations. This is observed through

changes in their lending structure and the Basel framework. However, there is a change in banks' behavior today compared with the beginning of the 21st century,

Table 4. Result from breakpoint test

Country\Variables	Loans to NFC < 1 year	Loans to NFC 1-5 years	Loans to NFC > 5 years	Loans to housing
Sweden	2005m08 (111.61)	2005m01 (55.16)	2005m01 (579.18)	2004m09 (34.64)
Break dates	2008m10 (65.70)	2008m01 (704.13)	2007m08 (12.87)	2010m09 (22.53)
(F-statistics)	2011m09 (17.15)	2011m03 (31.31)	2010m05 (432.10)	2016m08 (8.14)
	2016m08 (10.00)	2014m03 (46.63)	2014m10 (22.40)	
Germany	2005m08 (63.64)	2005m05 (16.56)	2005m05 (17.64)	2007m03 (19.79)
	2007m12 (123.81)	2008m01 (83.70)	2009m02 (54.06)	2009m09 (30.47)
	2010m12 (149.66)	2010m12 (170.90)	2012m12 (134.01)	2012m12 (981.23)
	2016m10 (40.76)	2013m04 (18.23)	2015m04 (44.03)	2016m06 (14.51)
		2016m10 (17.41)		
Italy	2006m06 (21.92)	2005m08 (26.52)	2005m05 (13.96)	2005m06 (34.21)
	2010m11 (106.38)	2008m10 (121.89)	2007m10 (60.30)	2007m10 (71.76)
	2014m01 (21.88)	2011m02 (8.87)	2011m12 (625.59)	2010m06 (75.00)
		2013m11 (1029.59)	2014m04 (13.96)	2012m10 (8.35)
		2016m10 (8.77)		2015m04 (60.12)
United Kingdom	2004m03 (52.07)	2004m03 (59.39)	2003m09 (45.29)	2004m09 (73.87)
	2007m09 (55.69)	2007m09 (45.81)	2007m09 (67.01)	2009m05 (508.83)
	2011m04 (126.38)	2011m05 (129.96)	2011m04 (121.75)	2014m03 (54.28)
	2016m06 (7.47)	2016m06 (8.70)		
Country\Variables	Commercial & industrial loans			Loans to Real estate
United States	2005m05 (57.62)			2006m09 (82.36)
Break dates	2009m12 (256.59)			2010m10 (130.45)
(F-statistics)	2012m04 (9.11)			2015m03 (555.07)
	2015m04 (7.76)			

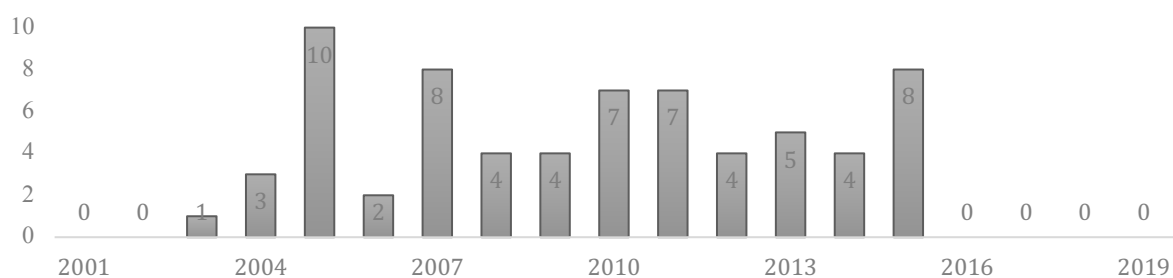


Figure 5. Summary over the breakpoint tests.

Discussion

The second part of the study's aim is to discuss possible macroeconomic effects in light of the result and theoretical framework. The initial result from the tests is that banks have changed their asset structure to focus more on housing loans, but not necessarily directly connected to the implementation of the Basel framework. Due to the result, this part of the analysis will focus on housing and how the current conditions might affect the economy.

A higher share of housing loans to total assets compared with the first years in the 21st century implies that banks are more dependent on the housing market today than previously. The housing market is known for playing a crucial role in numerous financial crises. For instance, the American housing market's impact on 2007-2008. Without any regulations today, there would have been reasons for concern for the increased dependence. This shifts the focus to the Basel regulations. First, the regulations are tougher today than they were for twelve years ago. This makes banks likely to be better prepared for a turbulent time today than before the crisis in 2007-2008, which decreases the systemic risk. Second, the introduction of countercyclical measures might play an important part. When an excessive credit growth or changes in asset prices are observed banks will be required to increase their capital to be prepared for worse times. By examining these aspects, there are reasons to believe that banks are better prepared than before. This is in line with several other studies as well that focus on the risk of a banking crisis, for instance, Almenberg et al. (2017) and Hall et al. (2012).

On the other hand, there are some concerns regarding the Basel framework capability to provide financial stability during tough times. The capital regulation has been criticised for being too complicated, where banks have incentives to underreport their level of risk (Begley et al., 2017). Also, the updated framework has never been tried during a real financial trough. Despite the updated framework, this is a vital aspect to consider. It takes time before new systems work as

they were intended. Nevertheless, if given the time there are reasons to believe that the Basel framework can reach its aim to enhance financial stability.

In conclusion, the findings of this paper imply that there are signs that banks have changed their behavior. This is observed in banks' lending practices, where a higher share of loans to housing can be observed towards the end of the period. These findings imply that banks might be more dependent on the housing market to stay stable. For future studies, it would be of interest to increase the number of countries, to see if there is a similar trend for all countries. It would also be interesting to follow up this study in a few years when the banks have got more time to adjust to the updated framework. Another approach that would be of interest would be to go more in depth. Instead of analysing the banks' behavior from data, it could be interesting to interview people in charge of different banks' strategies.

7 Conclusion

This study aimed to examine if the Basel regulations have affected banks behaviour, in regards to lending practices, and to analyse possible macroeconomic effects from it. To accomplish this, the method consisted of investigating the development of banks' balance sheets, with a focus on loans to housing and to non-financial corporates in Germany, Italy, Sweden, the United Kingdom, and the United States. To find structural breaks in the data multiple breakpoint tests were used. From the results five years deviated: 2005, 2007, 2010, 2011, and 2016. Neither of these years has a direct connection to the implementation of the Basel framework, but rather a connection to the financial crisis in 2007-2008. However, another finding is that banks have changed their asset structure to focus more on loans to housing, which has a lower risk weight compared to other loans. This implies that banks have adjusted their behaviour due to the updated framework, but it takes time for banks to adjust.

The second part of the aim was to discuss possible macroeconomic effects from the reactions of Basel in light of the framework and financial crises. The result from the test indicates that banks are more dependent on the housing sector to stay stable compared with in the beginning of the 21st century. From other studies and the Basel framework, banks are believed to be well prepared for an economic shock. Due to a more comprehensive framework with tighter capital requirements and countercyclical measurements compared with the financial crisis in 2007-2008. Nevertheless, there are some concerns regarding the complexity of the framework. For instance, there are signs that some banks have underreported their level of risk since there are incentives for banks to exhibit a low level of risk-weighted assets. In addition to this, the framework has not been tested during tougher times. It remains to see if it is enough to minimize the effect from a banking crisis.

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Appendix A

Members and institutions in the Basel Committee on Banking Supervision

Country	Institution
Argentina	Central Bank of Argentina
Australia	Reserve Bank of Australia Australian Prudential Regulation Authority
Belgium	National Bank of Belgium
Brazil	Central Bank of Brazil
Canada	Bank of Canada Office of the Superintendent of Financial Institutions
China	People's Bank of China China Banking Regulatory Commission
European Union	European Central Bank European Central Bank Single Supervisory Mechanism
France	Bank of France Prudential Supervision and Resolution Authority
Germany	Deutsche Bundesbank Federal Financial Supervisory Authority (BaFin)
Hong Kong SAR	Hong Kong Monetary Authority
India	Reserve Bank of India
Indonesia	Bank Indonesia Indonesia Financial Services Authority
Italy	Bank of Italy
Japan	Bank of Japan Financial Services Agency
Korea	Bank of Korea Financial Supervisory Service
Luxembourg	Surveillance Commission for the Financial Sector
Mexico	Bank of Mexico Comisión Nacional Bancaria y de Valores
Netherlands	Netherlands Bank
Russia	Central Bank of the Russian Federation
Saudi Arabia	Saudi Arabian Monetary Agency
Singapore	Monetary Authority of Singapore
South Africa	South African Reserve Bank
Spain	Bank of Spain
Sweden	Sveriges Riksbank Finansinspektionen
Switzerland	Swiss National Bank Swiss Financial Market Supervisory Authority FINMA
Turkey	Central Bank of the Republic of Turkey Banking Regulation and Supervision Agency
United Kingdom	Bank of England Prudential Regulation Authority
United States	Board of Governors of the Federal Reserve System Federal Reserve Bank of New York Office of the Comptroller of the Currency Federal Deposit Insurance Corporation

Source: BCBS (2016)