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Is Basel III Socially Beneficial in the Baltic Context?

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Signed

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Abstract

In this paper we analyse the costs and benefits of the Basel III capital requirements increase for the Baltic economies: Estonia, Latvia, and Lithuania. We take a sample of 29 commercial banks from the region, for the period from 2002 to 2013. Initially, we estimate the potential increase in capital ratio of the Baltic banks and the increase in cost of banks' capital as the result of lower leverage. Later, we assume that the increase in cost of capital is fully transferred to consumers and estimate the loss in output, driven by higher financing costs. In order to calculate benefits, we derive a GDP distribution and calculate the probability of crisis under Basel II and Basel III requirements. The decrease in probability of financial distress due to higher capital ratio represents social benefit. At the end, we arrive to a conclusion that Basel III does bring social benefits for the Baltic economies. The costs of output loss (-1.18% of GDP) does not exceed the benefits of lower costs of crisis (2.76% of GDP). The net benefit of Basel III in the Baltic region is 1.58% of GDP.

Contents

1 Introduction

In, 2010 Bank for International Settlements (BIS) delivered new tighter global regulatory requirements for the capital adequacy and liquidity indicators of financial institutions. The proposition was delivered under Basel III recommendation package. This immediately raised a lot of concern in the society, separating experts into opponents and promoters (Pandit, 2013).

Basel regulatory standards are issued by the Basel Committee on Banking supervision, settled under BIS in Switzerland. The first regulation was introduced after the liquidation of Herstatt Bank in 1988. Its aim was to control credit risk and classify commercial banks asset according to their riskiness. The following Basel II accord was issued in 2004 and focused on establishing certain standards on the amount of capital that banks should reserve for its commercial activities.

Upcoming Basel III is going to be fully adopted between 2014 and 2019. It introduces tighter capital requirements for the banks, additional capital buffers, leverage ratio, and net stable funding requirement. Basel III reflects troublesome issues of banks financing, which led to the financial crisis of 2007–2009 (BIS, 2011).

However, European member states do not apply Basel III standards straight away. European Commission has already issued a Capital Requirements Directive IV and Capital Requirements Regulation (CRD IV/ CRR) for Basel III adoption in the European Union. The major components in regulation stay the same as in Basel III, however, there are quite a number of differences in reporting and reward standards, addressed to the European banks through CRD IV/CRR.

There is plenty of research done on the global, European, and national levels. Economists, studying the impact of new capital requirement of Basel III on the European financial institutions, found that most of them would be forced to raise capital levels. Moreover, researchers predicted moderate increase in loan interest rates and, respectfully, decrease in volumes of newly issued debt. However, there is still insufficient amount of research on potential impact of Basel III on the Baltic financial sector and economic activity in the region.

The purpose of our paper is to study the effect of the increased capital requirements, proposed by Basel III and adopted through CRD IV/CRR, on the banking and real economy sectors in the Baltics. We analysed the change in cost of capital of commercial banks, driven by the decrease in leverage, and higher equity amounts on their balance sheets. We estimated how these changes might influence the overall output in the economy. Moreover, we analysed how these tighter requirements influence the probability of financial distress in the banking sector. Our aim was to measure the costs and benefits of the new regulation in terms of respectful changes in GDP for the three Baltic states: Latvia, Lithuania, and Estonia.

Even though in the European Union countries, in practice, CRD IV/CRR is implemented, in our analysis, we referred to the Basel III as the capital requirements are equal among both, while certain reporting standards are not in the scope of our research. Therefore, the research question we intend to answer is as follows: *What are the costs and benefits of the new capital requirements under Basel III for the banking and real economy sectors in the Baltics?*

The underlying hypotheses help identifying more concrete costs and benefits of the regulation on the real economy sectors in the Baltics:

H1: *Introduction of new capital requirements set in the Basel III will raise cost of capital for banks in the Baltic economies.*

H2: *New capital requirements will be socially beneficial for the Baltics, since the decrease in probability of financial crisis will outweigh the costs related to the output loss.*

In our analysis we compared the costs of implementation of the Basel III capital requirements to its benefits. We defined the costs as output loss in the economy, which happens due to an increase in the overall costs of capital. Social benefits are measured as reduction in the probability of financial crisis due to an increase in loss absorbing capital, which leads to less profound future falls in GDP in case of crisis. At the last stage of our analysis we compared the estimated costs of Basel III to the calculated benefits and concluded on whether it is socially beneficial for the Baltics or not.

The next chapter of the paper presents an extensive overview of Basel III and new capital requirements. Then, the literature review underlines the potential banks' reflections on tighter policies and its effects on the economy. Literature review is followed by the methodological background, methodology, and sample description sections. After, them empirical findings of our analysis and possible limitations and delimitations are presented. The paper is finalised with the conclusion section, stating the answer to the underlying hypothesis and the research question.

2 Basel III and CRD IV/CRR background

Basel III is a voluntary set package of rules issued by the Basel Committee on Banking Supervision, headquartered in the Bank for International Settlements in Basel, Switzerland. Members of 27 states in December 2010 have agreed on setting a new capital adequacy requirements in order to enhance banks' resilience against crisis. The requirements represent certain amounts of capital and additional buffers banks should maintain.

Under Basel III requirements, capital adequacy ratio (CAR), total equity on the banks' balance sheets against its risk-weighted assets (RWA) should represent at least 8% (see equation 1). Total equity is a proxy for Tier 1 and Tier 2 capital.

$$\begin{aligned} CAR &= \frac{Tier\ 1 + Tier\ 2}{RWA} \\ &= \frac{Capital + Reserves + Subordinated\ debt + Hybrid\ capital}{RWA} \end{aligned} \tag{1}$$

RWA is a special method of calculating bank's total assets according to their riskiness. Under such framework, certain assets are multiplied by the coefficient representing their riskiness; e.g. cash is multiplied by 0%, as it is riskless, while mortgage loans could be multiplied by 70% and some very risky loans might have coefficient even exceeding 100%. Nevertheless, RWA are always lower than total assets on the balance sheet, as not all of the assets have coefficient of 100%.

The recent financial crisis unveiled that the preceding Basel II capital requirements were not enough to absorb losses. Moreover, there existed such problem as pro-cyclicality of banks' capital, meaning that in times of economic growth banks were willing to lend more, due to higher profits, overheating the economy. On the other side, during the economic downturns, banks contracted part of its operations, harming survival of the real economy sector.

Basel III implies the same capital ratio of 8% to RWA, though changes certain requirements regarding Tier 1 capital decomposition. Now, shareholders' equity, capital of the highest quality, should be equal to 4.5%, while capital reserves and other elements represent additional 1.5%. Tier 2 capital remains at 2%. Apart from that, banks will be obliged to hold 2.5% capital conservation buffer, leading to total minimum capital requirement of 10.5%. Capital conservation buffer is implemented in order to control the level of capital that banks hold. In case CAR and capital conservation buffer will fall below 10.5%, banks will be restricted to pay out dividends until the required level recovers. Additionally, there are four more capital buffers: the counter-cyclical capital buffer, the systemic risk buffer, the global systemic institution buffer, and other systemic institution buffer. Moreover, each bank might decide to hold extra buffer of up to 2%, and regulatory supervisors (ECB for Europe) may require supplementary buffer of up to 2% more. The total capital requirement decomposition is shown in figure 1.

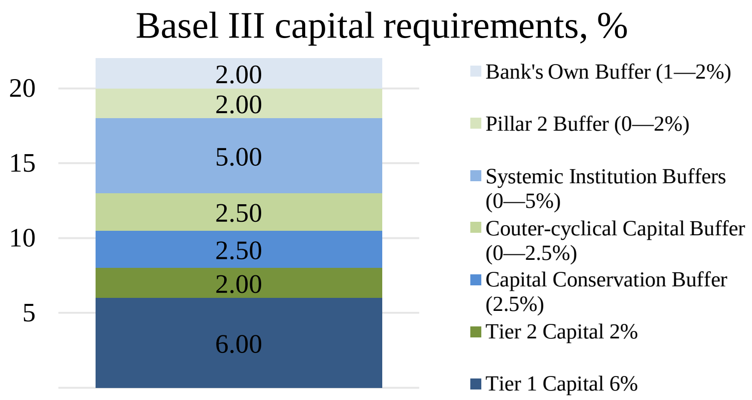

Figure 1
Decomposition of Basel III capital requirements into its components.
Source: European Commission (2013).

However, Basel III is not a law; rather it describes the proposed recommendations for the existing standards, as agreed among supervisors and central banks. Each separate legislation is responsible for Basel adoption. As for the European Union (EU), European Commission has issued the Capital Requirement Directive IV and the Capital Requirement Regulation (CRD IV/CRR) in order to embed new requirement into the EU member countries' legislation. The CRD IV/CRR legislative package was adopted and entered into force in 2013.

There were no major changes done to the original Basel III text regarding the capital requirements, rather the CRD/CRR stated certain frameworks for remuneration and reporting for the banks operating in the EU. It is worth mentioning, that the initial Basel III set of standards requires only internationally active banks to follow the rules, while the EU has decided to require all financial institutions in Europe to follow these rules. The decision is made upon high EU banks interdependence, caused by single market existence.

As the scope of our research concerns only capital requirements themselves, we further in the paper referred only to Basel III, as CRD IV/CRR does not contradict to it in terms of capital ratios. However, we took into account both internationally active and purely domestic market based banks, we also considered different amounts of capital buffers in order to perform sensitivity analysis.

3 Literature review

In the literature review, we discussed the most important concepts of Basel III regulatory standards, focusing on the main impacts that it may cause to the economy. Banks will certainly reflect on new regulatory standards which stayed into force on January 1, 2014. In order to adjust the level of capital, banks have two channels: deleveraging, which decreases the relative weight of debt (deposits) on the balance sheet, and pushing up lending rates in order to grow equity. Both methods of complying with the new standards imply some costs for the society, decrease in aggregate consumption, and output. At the same time, Basel III aims to decrease banks vulnerability and lower the probability of financial crisis. That is why the social benefits of the new standards were also touched upon. We measured the social benefits as lower probability of crisis for the economies in the future, meaning that the possibility of a sharp decrease in GDP will drop.

At the point of our research we did not have an access to the papers discussing Basel III and its effects on the Baltic economies, therefore Baltics separately are not discussed. All potential implications and evidence was brought from the researchers outside the Baltic region.

3.1 Channel I: lending rates

In order to raise capital and do not contract the balance sheet, banks might decide to raise lending rates. They are directly related to earnings, which increase the retained earnings, pushing up the capital ratio. Raising lending rates up is the quickest way to increase capital, since equity issuance process is rather costly and lengthy.

However, European Commission and Basel committee have thought about this problem and proposed gradual capital requirement increase until 2019, according to the schedule described in table 1. This should help economies to overcome severe and long term increases in lending rates.

Several European researchers have also brought attention to the problem of lending rates increase as a reflection to higher capital ratio. However, most of them agreed with the fact that increase in lending rates would be either insignificant or have influence only in the short run.

Akram (2012) made research about the Norwegian economy. In this paper, he investigates

	2014	2015	2016	2017	2018	2019
Minimum Common Equity Capital Ratio	4.000 %	4.500%				4.500%
Capital Conservation Buffer			0.625%	1.250%	1.875%	2.500%
Minimum Tier 1 Capital	5.500%	6.000%				6.000%
Minimum Total Capital plus Conservation Buffer	8.000%		8.625%	9.250%	9.875%	10.500%

Table 1
Basel III implementation schedule by years.
Source: BIS (2011).

the macro impact of higher bank capital requirements and the counter-cyclical buffer on the economy of Norway. The results suggest that the requirements interact with other variables mostly through lending rates, and minimum capital requirements effect on GDP is modest under Basel III. However, one should be aware that the increase in capital adequacy ratio may decrease output more, if it is simultaneously implemented in Norway's trade partner countries, due to high interdependence of market participants.

At the same time, Claus (2007) studied whether the costs of financial intermediation (lending rates in our case) influence the phase of adjustment to shocks in the economy. The empirical evidence he presented suggests that, for sure, the effects of changes in the monetary policies are more pronounced for the economies where many firms use bank financing rather than debt markets. However, he found that the pace of adjustment after economic shock is not a subject to the capital structure in a given economy. This implies that interest rates do not have a strong effect on the real economy in the long run, even if it is highly dependent on bank financing.

Nevertheless, it is not the growth of interest rates what is important, but its impact on the decrease in output in the economy. When the firms face higher borrowing costs, they might decide to seize part of operations. Study by Ozcelebi (2012) examines the effects of interest rate fluctuations on output growth in the economy on the example of Turkey and the Euro area. The author finds evidence that, in Turkey, an increase in short-term interest rates, approximated by 3-month interbank lending rates, leads to a statistically significant industrial output fall, which recovers in a year's time. However, the same analysis for the Euro area does not indicate any statistically significant effect neither in the short-term nor in the long-run.

There was a number of statistical research completed in Europe in order to find effects of Basel III on financial intermediation costs. One of them, published in the Czech Journal of Economics and Finance by Sutorova and Teply (2013), has approximated 54.9 basis points interest rate increase across the whole European financial market. We still believe that there might be interest rate increase in the Baltics, caused by tighter capital requirements, which might influence the output in the economy. Therefore, this is one of the scopes of our study.

3.2 Channel II: deleveraging

The other way how banks might react in order to fulfil regulatory standards of higher capital requirements is to reduce the amount of risk-weighted asset on their balance sheets. This would increase relative amount of equity against debt on banks' balance sheets. Due to the fact that minimum Capital Adequacy Ratio (CAR) is calculated against RWA, where most risky loans have higher weight than relatively secure ones, these risky exposures might be cut off. There is no uniform rule of how to measure RWA; however, certain loans are definitely more vulnerable than others. According to the Basel Committee on Banking Supervision, loans issued to households, small and medium enterprises, and unsecured loans are the ones that typically have higher weights in RWA calculation. That is why these exposures are the first ones to be cut if risk-weighted asset decrease is needed.

Many researchers proved that contraction of banks' balance sheets instantly lead to decrease in loan supply. Back in 1997, Peek and Rosengren studied economic implications of Basel I and binding capital requirements influence on bank lending. The authors developed an econometric model, where changes in issued loans are affected by risk-based capital ratio of the parent banks, controlling for other supply factors. They analysed the period from 1987 to 1994 on the US subsidiaries of the Japanese banks, thus isolating demand effects and obtaining pure supply effects. The results suggest that a percentage point decrease in risk-based capital ratio decreases credit volumes in the US subsidiaries of the Japanese banks by 6-percent annual rate, contracting funds that are available for the real economy sectors.

Allen, Chan, Milne, and Thomas (2010) did similar research rather recently, attacking Basel III on the grounds that increase in equity of all banks cannot come without significant losses in terms of lower long term economic growth. Their analysis is based on the UK banks and loan supply changes due to higher capital requirements. Researchers calculated that UK banks would be required to raise around GBP 18–60 billion of additional equity. Referring to JP Morgan, the authors state that, on average, world largest banks would be required to increase their equity (Tier 1 capital) by nearly 20%. These statistics support the fact that raising equity for the banks is not a fairly easy task. This would also involve restructuring a certain percentage of the existing investor deposits into long term financing, meaning equity.

Moreover, the authors also came to a conclusion that consumer loans, start-up, and small businesses, who often tend to innovate and provide a number of new employment places, are very likely to be cut off. Authors doubted the fact that banks would be efficient enough to raise a substantial amount of equity in short terms; therefore, the cut back on lending is nearly unavoidable. They believe that the effect of slower GDP growth would be much more pronounced than the decrease in systemic risk, lowering probability of crisis, in the economy.

However, as already mentioned above, households may also be harmed by the increase in capital requirements and bank instant deleveraging. American researcher Van den Huevel (2008) touched upon this problem in his study of Basel III implications on the economy. He applied a very sceptical approach toward the social costs of new regulation. The author stated the banks would be prevented from achieving liquidity due to a relative decrease in deposits on balance sheets, as equity and some longer term financing would be preferred.

The researcher used slightly modified standard growth model, introducing the bank as the intermediary agent that is able to provide liquidity for the households. Van den Huevel estimated social costs of the increase in the capital ratio based on the empirical finding on commercial banks in the US. He stated later that the increase in the capital ratio from 0 to 10% leads to a decrease in aggregate consumption in range from 0.94% to 1.04%. This is also reasonable due to fact that part of the households will be cut off from banks' client spectrum.

However, an alternative point of view exists too. Shaw, Chang, and Chen (2013) developed a dynamic equilibrium model involving households, firms, governments, and banks in order to find the effects of increasing CAR on macroeconomic variables.

The results that the authors got imply that banks would strive to lower funding gap in order to comply with the capital requirements. The deposit rates would be raised making firms would to obtain more debt, since the attractiveness of issuing equity to households decreases; larger return from their side may be expected due to higher deposit rates. At the same time during the economic downturns banks would tend to lend less and firms would tend to borrow less since the increase in leverage would imply higher vulnerability. That implies that the amount of loans on the market would be determined by economic conditions not the capital requirements themselves.

We, therefore, believed that studying the situation in the Baltic context is very important in order to understand the specifics of our local markets. Such varying opinions among researchers show that the there is no single truth written in stone and the effects of Basel III may vary in different economies.

3.3 Discussion of implications of Basel III

The real implications of Basel III are not yet crystal clear, as there are various opinions on this matter. For sure, stating that Basel III would only harm the economy through either higher lending rates or decreasing the loans supply is unreasonable. There are certain aims Basel III initiators are benchmarking and social benefits they are striving.

3.3.1 Decreasing bank asset vulnerability

Having more equity on banks' balance sheets might help to fight asset vulnerability problem. In case the bank's capital ratio is very low, even slight fluctuations in assets value may cause significant decreases in capital ratio and escalate the probability of the bank's default. At the same time, if equity amount increases, it stimulates bank's loss absorption abilities and strengthens its financial standing.

There is a plenty of papers published after the financial crisis of 2007–2009 and devoted to asset quality investigation. One of the most frequently referred one is presented by Stanford University researchers Admati, DeMarzo, Hellwig, and Pfleiderer (2011). They conducted the analysis in order to highlight the necessity of Basel III regulations. Referring the liquidity crisis of 2007, researchers stated that overly leveraged banks create negative externalities for the society as they become very sensitive to even slight changes in asset values.

Admati et al. (2011) argue that lowering the systemic risk for the whole financial sector produces great social benefit straight away. As in case of extensive debt financing, banks can be heavily interdependent, recession may cause financial instability for the whole sector. Equity financing instead would not only make banks less sensitive but also decrease their interdependence.

The ones who put a lot of emphasis on loss absorbing capital and tried to approximate the required level of CAR were Miles, Yang, and Marcheggiano (2012). Their aim was to study the impact of Basel III on the probability of financial crisis and on the level of output in the economy. The authors focused purely on domestic performance of financial institutions, ignoring their international activity. Due to very high interdependence between GDP losses and asset values, Miles et al. found that the previous minimum capital requirement of 8% (Basel II) was insufficient to cover banks' losses. After examining costs of crisis and potential losses, researchers came to a conclusion that Basel III does bring social benefits in terms of lower probability of financial distress. However, the optimal CAR should be around 15% of RWA, which is even higher than Basel III proposes (8% + 2.5% capital conservation buffer). Research of Miles et al. is also very specific for the UK banks, who hold way lower equity amounts than the Baltic ones.

On the other hand, not all studies come to a conclusion that higher equity ratio would imply more qualitative assets and lower vulnerability of banks. Early research made by Blum and Hellwig (1995) tried to determine the effect of capital adequacy regulations on the macro economy.

The authors argued that stricter capital requirements today decrease risk-taking today in a two-period model. However, anticipation that a bank will have to comply with capital requirements tomorrow, meaning that tomorrow it will have to have a certain level of equity, may lead bank to reconsider its level of profits. This may even enhance risk taking in order to raise equity amounts by allowing investing into riskier assets. This implies that banks will not issue additional equity, nor they will find other sources of financing, since this is very costly. The statement is objectionable from the Modigliani—Miller point of view, who state that the way of financing does not influence weighted average costs of capital, nor it influences returns. Nevertheless, authors argue that this is a reasonable assumption in the world where equity issuance is especially costly for banks, when, according to pecking order theory (Myers & Majluf, 1984), attempts to raise more capital will not only make stock prices go down, but will also affect customers' willingness to deposit their money, because they will question a bank's solvency, which makes even deposit financing more expensive.

Increase in minimum CAR may turn into cost for the society through two routes. The first is that banks, concerned with the amount of risky assets, can shift them to safer government securities from riskier loans to the private sector. The second is that banks, concerned with the required level of equity, may shift its assets to the riskier ones, increasing probability of higher returns, thus increasing the risk exposure of banks instead of decreasing it. Chiuri, Ferri, and Majnoni (2002) discussing various outcomes of the Basel accords in their paper stated that the effect of the of the first route may be especially strong in the emerging economies, since they rely on bank financing more due to limited public debt markets.

Another reason why banks might undertake more risk is because each separate asset, measured by its risk-weight, does not need so much equity as required for the whole bank. If the RWA is considerably lower than the actual assets in the balance sheet, there might occur 'capital surplus'. In order to use effectively all equity and provide a sufficient return for shareholder, banks might be willing to acquire riskier assets and lower the gap between RWA and the actual assets. Miu, Ozdemir, and Giesinger (2010), who made research on this issue, took 15% as an estimate for CAR. Their calculations show that such CAR can produce up to 64% of capital surplus, as each deal has rather moderate underlying capital inside. Such indicators imply potential deceleration in capital growth and decrease in profitability per unit of capital used. As a result, in order to maintain sufficient returns, bank might be willing to undertake riskier loans, which implies higher systemic risks to the economy.

3.3.2 Fighting moral hazard problem

Higher equity requirements may at least partially solve moral hazard problem—banks unjustified willingness to take on risk, striving towards monetary reward. As already discussed above, banks will be pushed to choose RWA more cautiously in order to avoid risky exposure and qualify under new standards. This would imply avoiding NINJA[1] loans. The term NINJA loans was a widely used concept during the liquidity crisis of 2007–2009, when banks were issuing credit to nearly everybody, including people with no stable income, no job, and no valuable and qualitative collateral.

Nonetheless, there are quite a number of academics who speak in favour of higher capital requirements and tougher control policies. For instance, above-mentioned Admati et al. (2011) stated that larger equity amounts on balance sheets should solve moral hazard problem. Management would not be able to seek empire building and make low return investments, since shareholders demand constant and adequate return. Since shareholders have direct control over the company and perform regular monitoring of financial standing and profitability, it is rather unlikely to walk them round (violate the data).

Increasing the required amount of capital for banks has both costs and benefits. Benefits are expressed as decreased willingness of banks to take excessive risks. Costs are expressed as the limitation of public companies opportunities for external financing as the result of banks'

[1] NINJA is an acronym for 'No Income, No Job, no Assets', which is used to describe very low quality subprime loans.

competition for equity with non-financial firms. This might increase both moral hazard problems and credit constraints, which both slow natural output growth in the economy, imposing social costs on all market participants.

Without regulations, banks are not willing to raise the required amount of capital, because they have to provide equity holders with returns comparable to the ones of industrial firms, which stimulates excessive risk-taking and increases banks' willingness to gamble. Regulations, however, can mitigate this situation.

In 2003, Gersbach developed a simple two-period model with one good and three types of agents: two types of people: entrepreneurs and consumers; and banks. The moral hazard problem is introduced in the model in the way that only an entrepreneur knows whether he will invest or consume obtained funding. There are three types of technologies in which banks can invest: gambling technologies, which produce the highest return with highest risk, moral-hazard technologies, which produce medium return with medium risk, and frictionless technologies, which produce low returns with low risk. By completing the analysis, the author proved, that within the framework of the model, banks will never achieve socially optimal level of capital adequacy[1] on their own. Thus, Gersbach states that capital requirement regulations are crucial for any economy. That is why we believe that a cost—benefit analysis of Basel III implementation in the Baltic states is very important in order to understand where the positive or negative externalities might occur.

3.3.3 Social benefits

However, what we focused on in our paper is the decrease in probability of banking crisis, measured in terms of GDP; this is the main social benefit of Basel III. We believed that the decrease in potential loss for the economy represents a serious increase in welfare and produces not only theoretical improvements in banks' asset quality and management moral hazard behaviour, but also decreases future GDP losses.

These Basel III gains are also measured by other papers' authors. Miles et al. (2012), who studied the effect of the Basel III on the macro economy of the United Kingdom, stressed exactly social benefits of the new rules. The authors argued that there are important factors that should be taken into account in attempt to assess the costs and benefits of higher capital requirements. This factors include but are not limited to: the extent to which capital adequacy

[1] Under the 'socially optimal level of capital adequacy' the authors understand the one that reduces the probability of banking crisis by at least the same amount as it harms long term economic growth.

regulations change the funding structure; the extent to which they impact tax revenues; the extent to which the probability of problems in the banking sector decline; the scale of macroeconomic costs that can be generated by problems in the sector.

The authors present a brief historical overview of lending rates spread over the T-bill rates in the United States, and found no impact of leverage on spreads. They explain it by the Modigliani—Miller theorem, which implies that when a firm issues more equity, volatility of returns fall, and therefore costs of debt and equity financing also fall, leaving the weighted average cost of financing unchanged (Modigliani & Miller, 1958). Therefore, the authors stated that there is no straightforward evidence that using more equity to finance the firm should increase the costs of lending. The authors argue that although the real world is more complex, there are evidences that Modigliani—Miller theorem is still a good approximation even for banks. The authors reference research by Kashyap, Stein, and Hanson (2010).

The results of Miles et al. suggest that even if the leverage is halved, then under reasonable assumptions this will lead to a marginal decrease of GDP growth, equal to 8–20 basis points, while the costs of financing will rise only by 10–40 bps.

Worth mentioning that following the logics of Miles et al. there is also one more positive implication of Basel III, namely income redistribution. Modigliani—Miller theorem is undermined by the fact that interest payments are tax deductible, and there are studies that prove that these tax distortions significantly influence capital structure of firms (Graham, 2003). And the higher requirements for equity are, the less tax shields can be exploited, which decreases banks' profits. However, the profits that are lost for banks are not lost for the economy; rather they are transferred to the government. Since these redistributed profits can be utilised for governmental purposes, they cannot be thought as social costs.

As it is now shown, there is a certain range of equity reserves that banks should achieve in order to be not vulnerable to economic fluctuations. Several researchers have found evidence that higher equity reserves do not cost for the society that much in terms of GDP reduction, we believe that Basel III regulation, which significantly differs from its precursors I and II, should serve as a great tool for improving stability, whose benefit should prevail against the potential costs of its implementation. This cost—benefit analysis is what we performed for the Baltic states in order to understand whether our economies would gain from such policy or whether there will be significant decrease in the aggregate output.

3.3.4 Counter-cyclicality of bank capital

Apart from minimal capital requirements, banks also need to maintain a certain amount of capital buffers: capital conservation 2.5% and countercyclical capital buffer of 0–2.5% in times of high credit growth or severe recession, as well as other potential buffers that could be defines either by bank itself or regulatory bodies.

These buffers are developed in order to have better control over the banks' exposure and in order to have control over it in times of rapid increases or recessions.. Capital conservation buffer will be held as an additional 'safety pillow'. How the countercyclical capital buffer will be exercised is not yet approved. However, the idea is that when the economy is booming and credit issuance is growing, as it happened in 2007, regulators should limit banks' ability to issue funds. While, when the economy is in recession, there should be additional stimulus for holding banks and enterprises solvent. When the CAR decrease banks are more willing to issue loans, since they do not need to check RWA carefully, whereas higher CAR implies cutting on loans. That is how countercyclical capital buffer is aimed to be utilised.

A separate study on banks' capital buffers was conducted by Blum and Hellwig (1995), substantially preceding Basel III. Authors investigated the necessity of certain buffers to control banks' lending. They developed a mathematical model to study the effect of regulations on the macro economy through capital buffers lens and underlined that the binding capital requirements will make macroeconomic fluctuations worse. In their model, whenever there is no binding capital requirements, a decrease in profits and hence in retained earnings and equity, will affect banks' willingness to lend much less, because they are not concerned of staying below the required level of debt-to-equity. While, when binding capital requirements are imposed, each additional unit of currency of profits will increase banks willingness to lend, since they are getting further away from the binding level and have lower chances of not complying with it. And the opposite is true for each additional unit of currency of losses. This, in turn, lowers the aggregate demand when the economy is already on the downturn, and increases the demand, when the economy is on the rise, overheating it.

In 2009, Repullo and Suarez got back to the issue and studied bank pro-cyclical behaviour via dynamic equilibrium model. The aim was to study the cyclicality of loan defaults with respect to business cycles in the economy. Solving the optimisation problem and obtaining statistical data on the US until the crisis of 2007, the authors concluded that capital buffers should have pro-cyclical movements in order to decrease welfare costs. Meaning that in times of economic expansion capital buffers should increase in order to compensate defaulting loans in the following periods of economic downturns or times of turbulences in the market. And the level of capital requirements should be lower in times of distress in order to have enough funds available for financing bad loans.

Moreover, if both Basel I and Basel II were not very helpful in terms of determining pro-cyclical movements of bank capital, the authors state that Basel III is much closer to dealing with the cyclicality issue due to the introduced buffers. This is one of the major reasons why Basel III got a way better expert assessment than the previous regulations.

4 Methodological background

There are various types of models and frameworks used by the researchers, when studying impacts of Basel regulation on the economies, though they may be divided into two groups: dynamic stochastic general equilibrium models (DSGE) and complex econometric time series models.

4.1 DSGE model

The DSGE model represents a simulation of the economy which has several underlying assumption. It includes all markets in the economy, believes that the demand and supply easily adjusts towards the equilibrium, there is no shortage or surplus as well as unemployment (only natural). Moreover, DSGE looks at the behaviour of the economy over time and involves the probability of unexpected shocks to happen. The model is widely used to study the effects of fiscal and monetary policies on different market participants and the economy in general. It estimates the effects of a new policy to various market participants and economic activities by applying a set of dynamic equations.

One example of a DSGE model was used by a Norwegian researcher Akram (2012). He studied the effects of higher CAR on the Norwegian economy. Akram examined the effects of higher CAR on interest rates, credit to households, credit to non-financial firms and real estate prices. He also made several assumptions regarding the effects of capital requirements. He assumed that historically observed impacts of tighter requirements on macroeconomic variables remain the same in the future, and that the central bank does not inflation under a certain target level. The whole model is composed of a few different equations including various exogenous factors such as oil prices and foreign economic indicators.

The sample used by Akram significantly exceeds the one we used in our research, moreover, he was concerned with the extent of interrelation of variables in his dynamic equations. Apart from that, the researcher also tried to model the work of counter-cyclical buffers according to various macroeconomic shocks. As the scope of our research is a little bit different and the availability of data is somewhat poorer, we decided to stick to a different methodology. In case of DSGE model, we might have had estimates significance problem, due to below moderate data amount. Apart from that, relying on historical causal relationships and assuming that they will hold in the future is somewhat unjustified in the context of the Baltics, especially due to financial crisis in 2009.

4.2 Modelling through the cost of capital

For our paper we decided to build the methodology on the work of Miles et al. (2012), where they gradually applied financial economics theorems and concepts in order to derive the real welfare costs and benefits at the end.

The underlying idea behind the model is to study the causal relationship between banks leverage and the costs of capital, which transfers to the financing costs and output in the economy. At first, the authors examined how responsive is banks cost of capital to changes in leverage levels, testing Modigliani and Miller proposition I. Later they tested how well does the Capital Asset Pricing Model (Markowitz, 1952; Sharpe, 1964) holds for UK banks, and specifically how well the implication of Capital Asset Pricing Model (CAPM) from the equation 2 holds.

$$\begin{aligned} \beta_{equity} &= \frac{D+E}{E}\beta_{assets} \\ R_{equity} &= r_f + (\hat{a} + \hat{b} \times leverage)R_P \end{aligned} \tag{2}$$

These equations imply that the riskiness of banks equity falls linearly with leverage and the positive sign of $\hat{b}$ implies that higher leverage for banks requires higher premium. The effect, however, can be even downward biased, because debt is treated as a purely risk-free under authors assumptions, while the cost of debt should also rise as the leverage rises.

Afterwards, the authors tested the responsiveness of enterprise output levels to the changes in financing costs, by estimating firms' output elasticity with respect to capital and the elasticity of substituting capital with labour. When the losses of outputs are estimated, the authors arrived to the final stage of their analysis and estimated benefits for the society in terms of lower bankruptcy costs. Miles et al. defined default as a situation when the value of bank assets falls more than the value of equity. The analysis, therefore, allows them to conclude that the increased equity helps banks to overcome large asset falls and positively impacts welfare in the economy.

We saw the methodology of Miles et al. to be applicable to the analysis of the Baltic banking sector under several modifications. There are various reasons behind such choice. Their approach allowed us to complete the analysis as it requires data which is publicly available at our disposal; it is based on the tools and concepts widely studied in our academic curriculum; and it clearly distinguishes between costs and benefits. As the result, we not only had a conclusion whether Basel III is socially beneficial in the Baltic context, but also have costs and benefits both expressed in terms of GDP. The DSGE models, however, do not allow distinguishing between costs and benefits clearly and calculating the real gain or loss as the result of new capital requirements. Moreover, as we were interested in capital levels only, working with cost of capital is the most direct and straightforward method.

The existing methodology of Miles et al. is also substantially modified, as we did not touch upon estimation of costs of capital through stock market returns. This is not applicable for the Baltics, because the local banks are not traded publicly. Moreover, we used different estimates for RWA of the Baltic banks, substitution coefficient between capital and labour, elasticity of output with respect to capital and the cost of crisis. All above-mentioned indicators are adjusted in order to fit the Baltic context. Moreover, we also perform extensive sensitivity analysis for testing various scenarios and different levels of capital requirements.

5 Methodology

In order to be able to make a cost—benefit analysis of higher capital requirements under the Basel III, we, first, identified and measured social costs of the increased capital requirements, and then measured their social benefits. Our analysis consisted of three stages.

First, we estimated the increase in costs of financing provided by banks due to an increase in capital requirements (which implies decrease in leverage). Then we analysed the transition mechanism of the increased cost of capital for banks to the growth in loan interest rates provided in the economy, and calculated the present value of a permanent decrease in GDP, obtaining the costs of stricter capital requirements.

Then we proceeded with calculation of the decrease in the probability of a broad financial distress, and the present value of its impact on GDP, thus obtaining benefits of the regulation.

At the end, we compared costs to benefits and concluded on whether Basel III is socially beneficial for the Baltics or not.

5.1 Costs

5.1.1 Estimating the effect of a decrease of leverage on firm financing costs

According to Modigliani—Miller proposition I (Modigliani & Miller, 1958), in the absence of market frictions, firms should be indifferent of choosing the capital structure, because it does not affect the value of a company. Levered and unlevered companies should have the same value, since shareholders of a levered company can replicate cash flow to the stockholders of an unlevered company by buying the debt of the levered company. For example, if two firms have earnings before interests of 100, and the levered one should pay 10 in interest and distribute 90 in dividends, while the shareholders of the unlevered company get 100 in dividends; then the stockholders of the levered company can buy the debt of that firm and completely replicate the cash flow.

However, the real world does experience market frictions. Bankruptcy costs are an example of frictions that increase the required return debt and equity more than in Modigliani—Miller proposition. Taxes, on the contrary, due to their deductibility of interests, decrease the predicted by Modigliani—Miller increase in the required return on debt and equity. Therefore, it is important to find the extent to which Modigliani—Miller proposition holds for financial institutions in our sample, and what is the relation between the weighted average cost of capital and the leverage.

Unlike Miles et al. (2012), we could not use a widely accepted measure of the risk of equities, which is the covariance of a company's returns with the market ones divided by the variance of the market returns, commonly referred as beta (Markowitz, 1952; Sharpe, 1964), because the Baltic banks were not listed, and therefore, the required inputs were impossible to obtain.

However, the main goal of the manipulations by Miles et al. was to determine the relationship between the leverage of a bank and its weighted average cost of capital (WACC). Therefore, we decided to estimate this link directly from the available financial statements. On the one hand, it decreased the number of observations compared to the market beta approach, because financial reports are usually available on a quarterly basis, while stock prices are possible to obtain on the daily basis (if we exclude intra-day trade). On the other hand, it allowed relaxing assumptions on the tax levels and the riskiness of debt.

The WACC is essentially the same as earnings before interest (EBI) divided by the total assets (A), as it expresses the profit demanded by both, debt and equity holders. In the longer run, however realised returns should converge to the expected ones. Therefore, we calculated the WACC using the reported net profit (NP) and interest expenses (I) for the period divided by the average total assets ($Av.\, A$) for the period (equation 3). Intuitively, one should use the average of the number in the beginning (A_{t-1}) and in the end of the period (A_t), because these were the assets that were used to generate the return.

$$\frac{EBI_t}{Av.\, A} = \frac{EBI_t}{\left(\frac{A_{t-1} + A_t}{2}\right)} \tag{3}$$

The leverage (as shown in equation 4) is defined as the total assets divided by the total equity (E), which is a proxy for the sum of Tier 1 and Tier 2 capital.

$$leverage_t = \left(\frac{A}{E}\right)_t \tag{4}$$

Then, we regressed the proxy for the WACC on leverage using a panel data and general least squared methods with entity fixed effects (γ_i), additionally controlling with dummy variables for time-specific effects (μ_t) and employing clustered sandwich estimators for variance-covariance matrix.

We tested a number of specifications, which are described in the appendix C (table C.1), however for the central estimates we used the output of regression in differences (equation 5), because it is theoretically the most sound one. First of all, the averages of both total assets (as a denominator for EBI) and the proxy for leverage is used, because EBI is determined by resources employed over the period, rather than in the beginning or in the end of it. The logic is very similar to the explanation why we use average assets for calculating the WACC. Second of all, by taking differences, we made sure that the data is stationary. And third of all, by controlling for entity-fixed effects we eliminated such omitted variables as differences in tax levels and differences in banks' business operations, while time-fixed effects eliminated the problem of omitted variables such as differences in the overall states of the economy.

$$\Delta\frac{EBI_t}{Av.\,A} = \beta_0 + \beta_1\Delta\left(Av.\,\frac{A}{E}\right) + \beta_2\left(\Delta\left(Av.\,\frac{A}{E}\right)\right)^2 + \mu_t + \gamma_i + \varepsilon_{it} \tag{5}$$

where the average assets-to-equity ratio is defined as in equation 6.

$$Av.\,\frac{A}{E} = \frac{\left(\frac{A}{E}\right)_{t-1} + \left(\frac{A}{E}\right)_t}{2} \tag{6}$$

The squared term was included, because it appeared significant and, therefore, indicated that there was a non-linear relationship.

We tested our regression on the matter of endogeneity and collinearity problem. The results showed that such problems are unlikely to occur, however more explicit explanation can be found in appendix C.

Then, knowing the difference between the minimum CAR under the previous Basel II regulation (8%) and the required capital ratio under the new Basel III regulation, we estimated the expected change in leverage, assuming that the ratio of risk-weighted assets to total assets would remain constant (*const*), which is a similar approach to the one described in the work by Miles et al. (2012). We assumed that all Baltic banks will at full implement capital conservation buffer, and therefore increase the ratio by 2.5%. Further in the work, CAR for Basel III is refereed as 8% capital ratio plus 2.5% capital conservation buffer, which gives a total of 10.5%.

$$CAR = \frac{Tier\,1 + Tier\,2}{RWA} \approx \frac{E}{RWA} \Rightarrow E = CAR \times RWA \tag{7}$$

$$\frac{RWA}{A} = const \Rightarrow A = \frac{RWA}{const} \tag{8}$$

$$\frac{E}{A} = \frac{CAR \times RWA}{\left(\frac{RWA}{const}\right)} = CAR \times const \tag{9}$$

$$\Delta\frac{A}{E} = \Delta\left(\frac{\frac{RWA}{const}}{CAR \times RWA}\right) = \Delta\frac{RWA}{const \times CAR \times RWA} = \Delta\frac{1}{const \times CAR}$$

$$= \frac{1}{const \times CAR_{III}} - \frac{1}{const \times CAR_{II}} = \frac{1}{const}\left(\frac{1}{CAR_{III}} - \frac{1}{CAR_{II}}\right) \tag{10}$$

Since the change in leverage ($\Delta A/E$) is also dependent on the absolute levels of CAR, not only the difference (equation 10), we had to make assumptions about them. We calculated the current average CAR for the Baltic banks and assumed that they would maintain the same risk strategy, meaning that they would keep the same difference between the minimum and the actual CAR. This implies that they would increase CAR from the current level by the size of the change in the minimum CAR.

Then we plugged in the leverage difference into the estimated relationship of the proxy for the WACC and the leverage, thus, obtaining the increase in the WACC (equation 11).

$$\Delta \frac{EBI_t}{Av.\,A} = \hat{\beta}_0 + \hat{\beta}_1 \Delta\left(Av.\,\frac{A}{E}\right) + \hat{\beta}_2\left(\Delta\left(Av.\frac{A}{E}\right)\right)^2 \tag{11}$$

Assuming that the average of the expected $(EBI_t/Av.\,A)$ over the longer run should be the same as the WACC, we made an assumption that this increase is transmitted directly to the interest rates that the bank clients face. This happens because bank, as any other firm, undertakes a certain project (lend money) only if the return on the project is at least equal to the bank's WACC, because it represents the weighted average return required to satisfy appetites of both debt and equity holders.

Interest rates (i) together with the capital depreciation rate (δ) comprise the cost of capital for borrowers (P_K). This is a widely used approach, which appears, for instance, in a number of macroeconomic models (Beņkovskis & Stikuts, 2006; Boissay & Villetelle, 2005; Fagan, Henry, & Mesre, 2001; Kattai, 2005; Livermore, 2004; Vetlov, 2004), but as long as it remains constant, it does not affect the change in cost of capital for borrowers and therefore is of no concern to us, as shown in equation 13.

$$P_K = i + \delta \tag{12}$$

$$\delta P_K = P'_K - P_K = (i' + \delta) - (i + \delta) = i' - i = \Delta i \tag{13}$$

where i' is a new level of interest rates.

5.1.2 Estimating the effect of an increase in the cost of capital on output

In order to estimate the costs for the economy, we calibrated the impact of an increase in the WACC for banks on the output of the economy. Here we followed a methodology employed by the Bank of England ("Financial Stability Report", 2010).

We assumed a Cobb—Douglas production function, determining the output (Y) by capital (K) and labour (L):

$$Y = f(K, L) \tag{14}$$

Looking at the supply side of the economy[1], we obtained that the total income in the economy (which is the same as the Gross Domestic Product according to income approach) is equal to the sum of income generated by the capital and labour. Thus, the total income is equal to the sum of incomes of two production factors, as shown in equation 15.

$$Y = P_L L + P_K K \tag{15}$$

Assuming that the factors are paid their marginal product, P_L is wage, and P_K is the cost of capital. Moreover, under the assumption of competitive markets, cost of capital is equal to the marginal product of capital (MPK):

$$P_K = \frac{dY}{dK} = MPK \Rightarrow \tag{16}$$

$$Y = P_L L + MPK \times K \Rightarrow \tag{17}$$

$$P_L L = Y - MPK \times K \tag{18}$$

with the total differentiation equal to

$$L dP_L = MPK\, dK - MPK\, dK - K\, dP_K = -K\, dP_K \tag{19}$$

$$\frac{d\,P_L}{P_L} = -\frac{dP_K}{K}\left(\frac{P_K}{P_L}\frac{K}{L}\right) = -\frac{dP_K}{P_K}\left(\frac{\alpha}{1-\alpha}\right) \tag{20}$$

Using the definition of relative prices ($P = P_K/P_L$) and denoting the elasticity of output with respect to capital as α, and the elasticity of substitution between capital and labour as σ, we arrived to

[1]Which is different from the most often used approach, which considers only the demand side ($A = AK^{\beta}L^{\alpha}$).

$$\frac{dP}{P} = -\frac{dP_K}{P_K} - \frac{dP_L}{P_L} = \frac{dP_K}{P_K}\left(\frac{1}{1-\alpha}\right) \Rightarrow \tag{21}$$

$$\frac{dP}{dP_K}\frac{P_K}{P} = \frac{1}{1-\alpha} \tag{22}$$

where $1/(1-\alpha)$ is the elasticity of relative price with respect to the cost of capital.

We assumed the constant elasticity of substitution, thus, the responsiveness of output to cost of capital could be presented in the following way:

$$\frac{dY}{dP_K}\frac{P}{K} = \left(\frac{dY}{dK}\frac{K}{Y}\right)\left(\frac{dK}{dP}\frac{P}{K}\right)\left(\frac{dP}{dP_K}\frac{P_K}{P}\right) = \alpha\sigma\frac{1}{1-\alpha} \tag{23}$$

In line with Krasnopjorovs (2012), we assumed that the elasticity of output with respect to capital (α) is about one third, while the elasticity of substitution between capital and labour (σ) is 1 for the Baltic economies. Therefore, the increase in the cost of capital transfers one-to-one to the cost of labour. However, we also performed a sensitivity analysis of these assumptions in appendix F.

Knowing these inputs, we estimated the permanent decrease in output, which is the cost of decrease in leverage (C), given the increase in costs of capital; and then we discounted it using a real social discount rate (d) of 2.5% (24) as suggested by Miles et al. (2012). The results with alternative discount rates are in appendix F.

$$C = PV(\Delta Y) = \frac{\Delta Y}{d} \tag{24}$$

5.2 Benefits

5.2.1 Estimating the benefits of the decrease in leverage

In line with Miles et al. (2012), we defined banking crisis as a situation when many banks come close to insolvency: when their assets lose more value than they have loss-absorbing capital. Such situations are likely to occur when market-wide or economy-wide shocks happen, rather than due to idiosyncratic bank-specific shocks.

An example of such economy-wide shock can be a decrease in GDP, because it leads to fall in incomes by the same relative amount. And assuming that the banks' assets consist of the domestic ones it expected that the value of banks' assets will follow the same relative decrease as GDP. Although the banks do not hold only domestic assets, the correlation among neighbouring economies makes the effect quite similar. Moreover, some evidence suggests that in the event of a banking crisis, the proportional fall in the value of banks' (un-weighted) assets is often equal to the proportional decline in GDP in nominal terms (Miles et al., 2012). However, we also made an analysis of whether this prediction held for the Baltic markets over the last crisis and found out that this is a decent assumption (for more information see appendix D), though, we slightly reduced the pass-through (PT) from 1 to 0.6894.

Unlike Miles et al. (2012), we decided not to calibrate the distribution of GDP growth, but employed the empirically obtained distribution, and applied bootstrapping method. In order to calculate the probability of the banking crisis, we calculated the probability that the asset values fall more than the loss-absorbing equity level, because when they fall more, it means that banks cannot absorb losses and are forced to go bankrupt. Such situation happens when assets proportionally fall more than the ratio of equity-to-assets, which can be expressed in terms of CAR and the risk-weighted to total assets ratio, as in equation 25. Such approach can be regarded as conservative, because a banking crisis and government intervention starts already when banks cannot maintain minimum capital requirements, not when their equity falls to zero.

$$\frac{E}{A} \approx \frac{Tier\,1 + Tier\,2}{A} = \frac{CAR \times RWA}{A} = \frac{CAR(RWA/A)A}{A} = CAR \times const \tag{25}$$

In order to understand the probability of the situation in which GDP falls more than a certain level (*threshold*), we simply divided the number of observations, when the growth was lower than this level, by the total number of observations in the sample.

Because the banks' asset values are not adjusted for inflation, it would be consistent to use nominal growth rates of GDP. However, countries with permanently high inflation (more than 50% annual inflation), such as Iraq, Mexico, Romania, Vietnam etc., which all had periods of high inflation in our sample, and especially countries with hyperinflation (more than 50% monthly inflation), such as Zimbabwe and a number of post-USSR countries in the beginning of the 1990s, significantly skew the GDP growth distribution. In order to mitigate this effect, and believing that such levels of inflation are not expected in the Baltic countries, we decided to use GDP data in real terms (Y^*) and adjust for inflation (π)[1]. We called the resulting GDP level,

[1]Although, it would be more precise to call it GDP deflator, we did not make distinctions between these two terms in our paper.

which is the same GDP change but expressed in nominal terms, threshold. Additionally, we adjusted the threshold to capture the effect of the less than one-to-one pass-through (equation 26).

$$threshold = \frac{\Delta Y^*}{PT} - \pi = \frac{\left(\Delta \frac{E}{A}\right)}{PT} - \pi \tag{26}$$

$$\begin{aligned} \Pr Cr &= \Pr(\Delta Y^* < threshold) \\ &= \frac{\#cases\ with\ \Delta Y^* < threshold}{\#observations} \end{aligned} \tag{27}$$

Then we estimated the expected cost of banking crisis (CoC), which was defined as the present value of the loss in output (equation 28).

$$PV(CoC) = \frac{CoC_0}{(1+d)^0} + \frac{CoC_1}{(1+d)^1} + \cdots + \frac{CoC_n}{(1+d)^n} \tag{28}$$

Thus, the benefits of changes in CAR are equal to the expected present value of an eliminated loss. However, the decrease in the probability of crisis is not a one-time event, but something that would continue to be there forever. Therefore, we also calculated the present value of this effect using a perpetuity formula in eqution 29.

$$B = -\frac{(\Pr Cr)' \times CoC - \Pr Cr \times CoC}{d} = -\frac{CoC\, \Delta \Pr Cr}{d} \tag{29}$$

where $(\Pr Cr)'$ is the probability of banking crisis before the change in equity level.

Having quantitatively measured both costs and benefits of the proposed increase in capital requirements, we compared costs to benefits and derived conclusions regarding whether the policy is socially beneficial or socially harmful.

The net benefits are calculated as the benefits less the costs of the increases in CAR as in equation 30.

$$Net\,Benefits = B - C \tag{30}$$

6 Sample description

For our study we took a sample of 29 regularly operating Latvian, Lithuanian and Estonian banks. In total we had 16 Latvian, 7 Lithuanian, and 6 Estonian banks (full list in the appendix E). We used only legal entities in each country, not a parent company or a branch of an international one. Datasets containing quarterly information on bank financial statements were not available for us. Therefore, in order to form a database of the needed sample, we analysed and manually extracted data from each financial statement of the above mentioned banks that was publicly available. All of the data was converted into Euros using the pegged exchange rates of Latvian Lats (0.702804), Lithuanian Litas (3.4528) and Estonian Kroon (15.6466).

The period of the study is 11 years, 2002–2013, and it contains in total around 900 observations. We decided to follow this range due to sufficient observation number and data availability.

In December 2013, the equity-to-assets ratio of the Baltic banks varied between 4% to 30%, and most of the banks already qualified for the minimum Basel III capital requirements, which are due only in 2019.

In order to get GDP growth rate distribution and calculate social benefits from new capital requirements, we obtained data from the UN Statistic Divisions (2013). The dataset covers 218 countries for the period from 1970 to 2012, which in our case is large enough to see the general tendency of GDP distribution (figure 2).

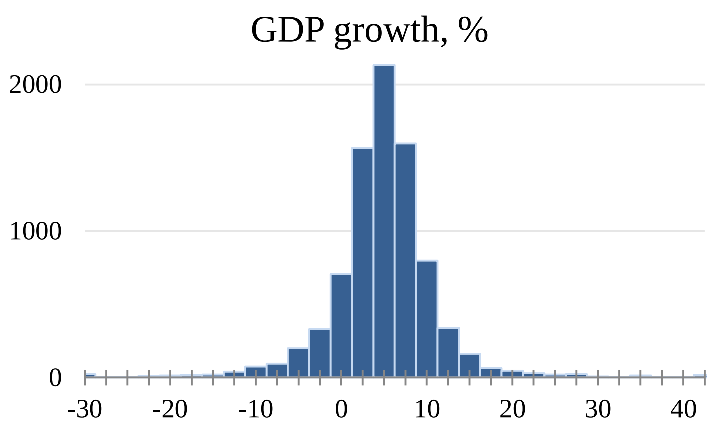

Figure 2
The distribution of the real GDP growth (%) in national currency and constant prices from the sample.
Number of observations with the GDP growth within a certain interval is on the y-axis.
Source: UN Statistic Divisions (2013).

Our sample shows that a loss absorption ability is very important for banks. The last crisis has proven that equity is the primary tool to compensate losses. In 2009, Baltic banks faced a significant income drop. In Lithuania, ROE was −65%, while Latvian banks faced negative ROE for two years, 2009 and 2010, amounting at −50% and −15% respectively. Losses in Estonia were much more moderate, around 16% in 2009. These statistics show that banks are very vulnerable to fluctuations in asset values and discovering optimal capital level is important. The tendency of banks profitability is shown in the figure 3.

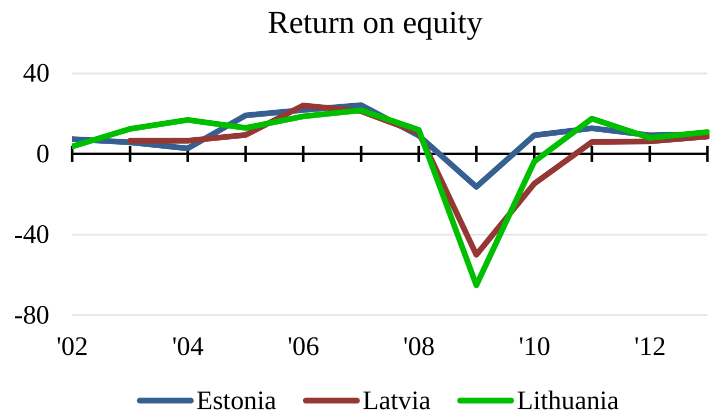

Figure 3
The development of returns on equity of the Baltic banks from the sample over the period from 2002 to 2013.

7 Empirical results

7.1 Estimating costs of a decrease in leverage

The results of the regression of changes in return on assets on changes in leverage are summarised in table 2.

Since the regression that controls for both time and entity specific effects should be more theoretically correct and has the highest R-squared, we used its results for estimation. However, it is worth noticing that the results of all of the regressions are consistent among each other. Moreover, intercept appears to be insignificant, which implies that there are no changes in the WACC given no changes in leverage and holding everything else constant. The insignificance of the intercept is in line with expectations.

The minimum CAR under Basel II was 8%, while Basel III introduced a number of additional buffers, which are described in detail in section 2 and figure 1, making a new minimum CAR equal to 10.5%.

	Pooled OLS	Fixed effects (within-estimator)	Time fixed effects (LSDV)	Fixed effects with quarter dummies
	$\Delta\frac{EBI_t}{Av.A}$	$\Delta\frac{EBI_t}{Av.A}$	$\Delta\frac{EBI_t}{Av.A}$	$\Delta\frac{EBI_t}{Av.A}$
$\Delta\left(Av.\frac{A}{E}\right)$	−0.000546 (−1.38)	−0.000607 (−1.47)	−0.000636* (−1.86)	−0.000696* (−1.91)
$\left(\Delta\left(Av.\frac{A}{E}\right)\right)^2$	−0.000069*** (−9.00)	−0.000087*** (−10.17)	−0.000064*** (−12.67)	−0.000084*** (−12.36)
Intercept	−0.000072 (−0.34)	−0.000121*** (−7.73)	0.001672 (0.46)	0.000746 (0.21)
N	824	824	824	824
R^2	0.02	0.03	—	0.15

Table 2
The regression estimates of changes in the proxy for the WACC on changes in the proxy for leverage. The average of the dummies for quarters is included in the intercept. T-statistics are in brackets.
*—p-value<0.1, **—p-value<0.05, ***—p-value<0.01
Note: regression specification is based on eqation 5.

The buffers, however, are not thought to be there all the time with their maximal possible values. That is why we calculated increases in CAR, and also increases in leverage for various possible scenarios. Moreover, it was not clear yet how some of them will operate. Therefore, we decided to avoid using all buffers in our central estimates, though the results with the various number and size of the buffers are presented in appendix F.

Firstly, we had to calculate the ratio of total assets to risk-weighted assets for the Baltic banks, which is labelled as *const* in the equation 8. We used the latest available data for the three countries and then took the weighted average (by the asset size in the Euros), because the number and the total size of the banks differ significantly among the three states. The results are presented in the table 3 and the figure of 0.7195 is used in our calculations.

Then, knowing the difference in leverage caused by the changes in CAR requirement, we obtained estimates for the expected increase in the WACC under various scenarios (various number and size of different buffers proposed by the Basel III). The results are presented in the table 4.

The results suggest that the WACC will increase by somewhere from 0.01 to 0.12 pp. However, it is very unlikely that all of the buffers would be imposed on all of banks in the economy, because some of them are bank specific buffers, while the others are temporary. Therefore, we should pay more attention to the upper part of the table. And the central estimate

Country	CAR	Equity, €	Assets, €	RWA, €	RWA/A
Latvia	0.1804	3,138,999	29,192,261	17,400,216	0.5961
Lithuania	0.1560	2,247,778	21,821,231	14,408,835	0.6603
Estonia	0.2000	3,826,711	19,793,032	19,133,555	0.9667
Weighted average	0.1784				0.7195

Table 3
Source data used to calculate the ratio of total assets to risk-weighted assets and the results of the calculations, using the latest available data. The weights for weighted average are calculated based on the asset size.
Source: Financial and Capital Market Commission (2014), Bank of Lithuania (2014), Bank of Estonia (2014).

(increase in CAR by 2.5%) is equal to 0.06 pp.

From the production function, 1 pp increase in cost of capital leads to $\sigma\frac{\alpha}{1-\alpha}\%$ permanent fall in output. Knowing the values of α and σ, we calculated the annual fall in GDP, and then, the present value of all future falls, and discounted it using a social discount rate (2.5%). The present value of the decrease in output is the cost of the new capital requirements. The results are reported in table 4 with the central estimate being equal to 1.18% of GDP.

7.2 Estimating benefits of a decease in leverage

Given the definition of the crisis and the assumption of its relationship with GDP dynamics, we calculated the probability of a banking crisis under the Basel II, Basel III, and their difference.

Using the bootstrap method, we calculated the probability that the GDP growth would be lower than a certain value (*threshold*) for different levels of the equity-to-assets ratio[1], and the results are summarised in table 5.

We assumed the inflation rate of 0% to be adequate. We are interested in the left side of the GDP growth distribution, which is significantly below zero, and therefore we pay attention to GDP dynamics during the recessions. During these periods, however, inflation usually falls. Our estimates of inflation during the periods of downturns suggest that it was on average equal to -1.76% in the Baltic countries during the last crisis in 2009 (see appendix D). However, we believe that tighter inflation control and Lithuania's inclusion in the Eurozone since January 1, 2015 should decrease the volatility of inflation among the three states. Thus we use a more conservative estimate of 0% for inflation, though analysis of alternative scenarios for other price growth rates are in appendix F.

[1] *threshold* is essentially the equity-to-assets ratio adjusted for inflation.

ΔCAR, pp.	New CAR, %	$\Delta\frac{A}{E}$	ΔWACC, pp.	ΔY, % of GDP	PV(ΔY), % of GDP
0.5	18.3359	−0.2125	0.0144	−0.0072	−0.2883
1.0	18.8359	−0.4137	0.0274	−0.0137	−0.5473
1.5	19.3359	−0.6045	0.0390	−0.0195	−0.7805
2.0	19.8359	−0.7857	0.0495	−0.0248	−0.9906
2.5	**20.3359**	**−0.9580**	**0.0590**	**−0.0295**	**−1.1803**
3.0	20.8359	−1.1220	0.0676	−0.0338	−1.3516
3.5	21.3359	−1.2784	0.0753	−0.0377	−1.5066
4.0	21.8359	−1.4275	0.0823	−0.0412	−1.6468
4.5	22.3359	−1.5700	0.0887	−0.0443	−1.7738
5.0	22.8359	−1.7063	0.0944	−0.0472	−1.8889
5.5	23.3359	−1.8367	0.0997	−0.0498	−1.9933
6.0	23.8359	−1.9616	0.1044	−0.0522	−2.0880
6.5	24.3359	−2.0814	0.1087	−0.0543	−2.1738
7.0	24.8359	−2.1964	0.1126	−0.0563	−2.2518
7.5	25.3359	−2.3069	0.1161	−0.0581	−2.3224
8.0	25.8359	−2.4130	0.1193	−0.0597	−2.3865
8.5	26.3359	−2.5152	0.1222	−0.0611	−2.4447
9.0	26.8359	−2.6135	0.1249	−0.0624	−2.4973

Table 4
The estimated changes in the WACC given different levels of changes in CAR, assuming the initial CAR equal to 17.8359 %. And the present value of the effect of the changes in WACC on output (costs). Central estimates are in bold.
Note: ΔA/E is calculated based on equation 10, ΔWACC is calculated based on equation 11, ΔY is calculated based on equation 23, and PV(ΔY) is calculated based on equation 29.

The average cost of crisis (CoC), or output loss, for developed economies was estimated to be 32.9% of GDP and lasted for 3 years (Laeven & Valencia, 2012). Assuming that the output loss is the same for all three years (10.9667% each year), the present value of the cost of crisis, based on equation 28, was 32.1041% of GDP.

$$PV(CoC) = \frac{10.9667\%}{1} + \frac{10.9667\%}{1 + 2.5\%} + \frac{10.9667\%}{(1 + 2.5\%)^2} \approx 32.1041\% \tag{31}$$

The cost of crisis, however, is not a straight-forward number. On the one hand, the same authors report that cost of the last crisis in Latvia was 106% (Laeven & Valencia, 2012), moreover Miles et al. (2012) use a larger estimate of 140%. On the other hand, even 34% seems to be a very high number. Moreover, Laeven and Valencia (2012) calculated potential loss by taking a difference between GDP value during the crisis and the preceding trend. However, since prior to the crisis the economies of the Baltics were overheated, trend is rather ambiguous. Therefore, it is reasonable to assume that the real cost of crisis is lower. We performed a

E/A, %	$\Pr(Cr\|\pi)$, %				
	$\pi = -2\%$	$\pi = -1\%$	$\pi = 0\%$	$\pi = 1\%$	$\pi = 2\%$
10.0000	1.0036	1.1231	1.2425	1.3978	1.6249
11.0000	0.8602	0.9438	1.0992	1.1470	1.3501
12.0000	0.7288	0.8124	0.8961	1.0036	1.1350
12.8323	**0.6571**	**0.7049**	**0.8005**	**0.8722**	**1.0036**
13.0000	0.6571	0.6691	0.8005	0.8602	0.9677
14.0000	0.5137	0.5615	0.6571	0.7288	0.8244
14.6309	**0.4659**	**0.5257**	**0.5854**	**0.6571**	**0.7288**
15.0000	0.4540	0.5018	0.5376	0.6571	0.6930
16.0000	0.3943	0.4301	0.4659	0.5257	0.5854
19.0000	0.2628	0.2987	0.3345	0.3584	0.3823
20.0000	0.2151	0.2628	0.2867	0.3226	0.3465

Table 5
Probabilities of crisis, given different values of the equity-to-assets ratio and different inflation rates (π). Figures in bold are used for calculation of central estimates.
Note: probabilities of crisis are calculated based on equation 27.

sensitivity analysis for other potential values of the cost of crisis in appendix F.

The estimated values of benefits for inflation of 0% are reported in table 6, and the central estimate suggests that the present value of the eliminated expected cost of crisis (benefits) due to of increase in capital requirements is 2.76% of GDP.

7.3 Weighting costs against benefits

Mainly, the difference between the costs and benefits depends on the new assumed increase in the CAR. The results are summarised in the table 7.

The results suggest that the net benefits of the increases in CAR under the Basel III are positive. The conclusion is insensitive to inclusion of additional buffers, because with the increase of CAR by more than 2.5%, which is used as the central estimate, net benefits remain positive.

The net benefits, however, are quite small, with their present value being equal to 1.58% of GDP, and being comprised of the present value of benefits equal to 2.76% and the present value of costs equal to 1.18%.

The results, however, should be treated carefully, because they rely on numerous assumptions and proxies, which might not hold in reality. In order to mitigate this problem, a sensitivity analysis of the most important inputs is performed in appendix F.

Overall, the sensitivity analysis suggests that the sign of the net benefits remain quite

ΔCAR, pp.	New CAR, %	Old $\frac{E}{A}$, %	New $\frac{E}{A}$, %	$-\Delta \Pr(Cr)$, pp.	Decrease in $PV(\mathrm{E}[CoC])$, % of GDP
0.5	18.3359	12.8323	13.1920	0.0597	0.7671
1.0	18.8359	12.8323	13.5517	0.1075	1.3808
1.5	19.3359	12.8323	13.9115	0.1434	1.8411
2.0	19.8359	12.8323	14.2712	0.1434	1.8411
2.5	**20.3359**	**12.8323**	**14.6309**	**0.2151**	**2.7616**
3.0	20.8359	12.8323	14.9907	0.2628	3.3753
3.5	21.3359	12.8323	15.3504	0.2867	3.6822
4.0	21.8359	12.8323	15.7101	0.2987	3.8356
4.5	22.3359	12.8323	16.0699	0.3345	4.2959
5.0	22.8359	12.8323	16.4296	0.3465	4.4493
5.5	23.3359	12.8323	16.7893	0.3704	4.7562
6.0	23.8359	12.8323	17.1490	0.3943	5.0630
6.5	24.3359	12.8323	17.5088	0.4182	5.3699
7.0	24.8359	12.8323	17.8685	0.4182	5.3699
7.5	25.3359	12.8323	18.2282	0.4301	5.5233
8.0	25.8359	12.8323	18.5880	0.4540	5.8301
8.5	26.3359	12.8323	18.9477	0.4659	5.9836
9.0	26.8359	12.8323	19.3074	0.4779	6.1370

Table 6
Changes in the annual probability of crisis, decrease in the expected cost of crisis, and the present value of the decrease in the expected cost of crisis (benefits) for different values of new CAR, assuming the initial CAR equal to 17.8359 %. Central estimates are in bold.
Note: the equity-to-asset ratios are calculated based on the equation 25, probabilities of crisis are calculated based on equation 27, benefits (decrease in $PV(\mathrm{E}[CoC])$) are calculated based on equation 29.

stable, though the size of it varies. Assumptions that within the reasonable boundaries make the net benefits negative are the elasticity of output with respect to capital (α, the size of the pass-through of GDP falls into asset value decrease, and the cost of crisis.

The elasticity of output with respect to capital makes the net benefits negative, having the values of 0.5 and higher (our assumption was that it is 1/3). The result is consistent with the expectations, because the more output is dependent on capital, the more increase in the cost of capital would decrease the overall output.

If the pass-through of GDP fall into the asset value declines is less than 0.5 (though the value significantly varies for different levels of the current CAR), the net effect of the increases in the capital requirements also becomes negative.

And if the cost of crisis is about 10%, the net benefits also become negative.

The sensitivity of net benefits to the last two variables, which are the pass-through size

ΔCAR, pp.	New CAR, %	PV of benefits, % of GDP	PV of costs, % of GDP	Net benefits, % of GDP
0.5	18.3359	0.7671	0.2883	0.4789
1.0	18.8359	1.3808	0.5473	0.8335
1.5	19.3359	1.8411	0.7805	1.0606
2.0	19.8359	1.8411	0.9906	0.8505
2.5	**20.3359**	**2.7616**	**1.1803**	**1.5814**
3.0	20.8359	3.3753	1.3516	2.0237
3.5	21.3359	3.6822	1.5066	2.1756
4.0	21.8359	3.8356	1.6468	2.1888
4.5	22.3359	4.2959	1.7738	2.5221
5.0	22.8359	4.4493	1.8889	2.5604
5.5	23.3359	4.7562	1.9933	2.7629
6.0	23.8359	5.0630	2.0880	2.9750
6.5	24.3359	5.3699	2.1738	3.1960
7.0	24.8359	5.3699	2.2518	3.1181
7.5	25.3359	5.5233	2.3224	3.2008
8.0	25.8359	5.8301	2.3865	3.4436
8.5	26.3359	5.9836	2.4447	3.5389
9.0	26.8359	6.1370	2.4973	3.6397

Table 7
The net benefits of changes in the minimum CAR, expressed as percentage of GDP, assuming the initial CAR equal 17.8359%. Central estimates are in bold.
Note: net benefits are calculated based on equation 30.

and the cost of crisis, are the most important ones, because they are relatively close to the our assumed values. However, Miles et al. (2012) assumed much higher both cost of crisis (140%) and the pass-through (1). While Laeven and Valencia (2012) estimated that the cost of the last crisis for Latvia was 106% of GDP. Thus, since other authors report much higher numbers, we believe that our results are already conservative enough.

8 Limitations and delimitations

The study is a subject to a number of drawbacks and delimitations. One of the most important delimitations is that we looked only at one aspect of the whole package of regulations, specifically we looked at how higher capital adequacy requirements, would influence the weighted average cost of capital, holding everything else constant. However, it might be reasonable to expect that the new regulations will cause structural changes in these relationships. Moreover, we focused solely on capital requirements proposed by Basel III and did not take into account minimum leverage ratio, net stable funding ratio, as well as reporting and reward policies proposed by

CRD IV/CRR.

The next important delimitation of the work is relying on various assumptions regarding capital structure, inflation etc. Nevertheless, we tried to mitigate this problem as much as possible by providing alternative results given other values for assumptions and providing sensitivity analysis for our inputs.

Another problem is that results of the regression might be sample specific and hold only for the chosen banks over a certain period of time. We tried to tackle down this issue by running the same regression for two subsamples, however, it appeared that the estimated coefficients for the two subsample differ almost twice. And although, it does not change the final conclusion about the sign of the net benefits of the proposed regulation, it raises concerns that the obtained results might differ significantly for other periods or other countries. That is why our analysis is limited to to the Baltics and banks operating in this region.

The regression also has a number of other potential limitations. Even though we control for all omitted variables that are constant either over time or over entities, there still might be endogeneity problem, caused by variables that vary both over time and over entities and are correlated with both the dependent variable and the regressor. It is also possible that the regression has a causation problem. It could be that not the leverage influenced the required return, but rather firms anticipating lower returns leveraged their positions in order to increase the return to shareholders.

Furthermore, our sample might suffer from survival bias, because we included only those banks that were operating at the end of 2013. For instance, we did not include Snoras and Latvian branch of Parex bank, because their financial statements were unavailable for us. However, we believe that there were other reasons why these banks went bankrupt, and not due to controversial relationship between their WACC and leverage. Therefore, bankrupted banks omission should not significantly skew our results.

Employment of a simple Cobb—Douglas production function eliminates our ability to analyse the short run effects, while they might impact the present value of costs, due to its nature that the nearer future has higher relative effect than the more distant one.

Another drawback was that we used historical GDP distribution. However, it might change in the future, because the probability of crisis decreases if leverage decreases, and loans decrease in the economy, makes it less dependent on bank financing, leading to lower costs of banking crisis. Such changes might cause GDP distribution to differ from its historical performance. However, we already used conservative estimates for the cost of crisis and provided a sensitivity analysis for cases when the cost of crisis is even lower.

Although usage of historical GDP distribution solves a number of problems, such as the necessity to calibrate analytical distribution functions, it raises a few other issues. We are concerned with its left tail. However, this range has relatively low number of observations, therefore there are at least two problems due to that. First of all, it is impossible to predict the effect for very small changes in leverage, because it might be that there are no observations within this range. Second of all, due to its empirical nature, the distribution has numerous local maxima and minima, thus, net benefits appear to be non monotonic, which might look like inconsistent results. An example of such effect can be seen in table 7 for new CAR levels of 19.4, 19.9, and 20.4.

In general, we did not see truly great drawbacks or delimitations that might lead to ambiguous or different from what we got results.

9 Conclusions

The issue of Basel III is rather controversial and, as our review of related literature has shown, there is not yet one opinion about the effects of tighter capital requirements on the economy. In various states and regions researchers arrive to different results and numbers. Therefore, analysis of this matter for the Baltics also adds value to the overall Basel III impact evaluation.

We have analysed 29 regularly operating commercial banks from Estonia, Latvia, and Lithuania for the period from 2002 to 2013. Under the assumption of maintaining the same pattern in bank capital amount as before, holding constant reserve above the minimum requirement, CAR rises by 2.5 pp., from 17.8% to 20.3%. CAR for Basel III in our analysis includes minimum capital ratio of 8% and a fully implemented capital conservation buffer of 2.5%. Larger CAR under the new Basel implies leverage decrease by 0.96 and an overall cost of capital (WACC) increase by 0.06 pp. Thus, answering the 1st hypothesis that tighter capital requirements do increase the costs of capital for the commercial banks in the Baltics.

Further calculations, under the assumption that banks would transfer cost of capital increase to consumers, show that the present value of potential decrease in output might be somewhere around 1.18% in terms of GDP. Effectively, it happens through the increase in lending rates. However, the positive side of Basel III is that when loss-absorbing capital increases it leads to lesser banks' vulnerability. Under Basel III the threshold for loss in asset value and bank going bankrupt increases. The probability of financial crisis falls by 0.22 pp; meaning lower expected costs of crisis in the long run. Lower costs of crisis implies decrease in the present value of the expected cost of crisis by 2.76% of GDP. This proves our 2nd hypothesis on benefits prevailing against costs.

The analysis allows us to conclude that the overall impact of Basel III on the Baltic economies is positive. Thus, answering the research question, we proved that there will be costs due to output loss and benefits due to lower probability of crisis. However, the present value of benefits of the new requirements exceeds the present value of costs, leading a slightly positive net effect of 1.58% in terms of GDP.

Definitely, the social benefits of Basel III are far more than pure numbers. Lower banks vulnerability against financial distress also imply that the taxpayers will not be rescuing and financing the bail-out processes of saving distressed banks. Moreover, as the last crisis has shown, sufficient capital base is absolutely essential for banks in order to absorb losses.

There are certain aspects that we in our research did not take into account or did not study in depth. As an implication for further research we propose using a more complex macroeconomic models in order to capture both long and short run of the increase in cost of capital. Moreover, our analysis is narrowed down to examining only capital requirements. However, Basel III and CRD IV/CRR propose also other tools aimed at improving banks financial stability. In order to analyse the effect of the whole recommendation package more nuances should be taken into account. Last but not least, one could try to estimate optimal capital requirements specifically for the banks in the Baltics.

In general, we arrived to the conclusion that we have expected in the very beginning of our research, and have proved the necessity of tighter capital requirement in the Baltics. This work could also serve as a good piece of thought for further research on the topic.

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Appendix

A Sample description

Bank	Country	Period
Aripank	Estonia	2002–2013
BIG Bank	Estonia	2008–2013
Krediidipank	Estonia	2005–2013
LHV	Estonia	2009–2013
SEB	Estonia	2005–2013
Versobank	Estonia	2005–2013
ABLV	Latvia	2008–2013
Altum	Latvia	2003–2013
Baltikums	Latvia	2005–2013
Citadele	Latvia	2010–2013
DNB	Latvia	2007–2013
Expobank	Latvia	2007–2013
Pasta Banka	Latvia	2009–2013
Norvik Banka	Latvia	2007–2013
PrivatBank	Latvia	2006–2013
Reģionāla Investīciju Banka	Latvia	2004–2013
Rietumu Banka	Latvia	2006–2013
SEB	Latvia	2007–2013
SMP	Latvia	2010–2013
Swedbank	Latvia	2006–2013
Trasta	Latvia	2007–2013
UniCredit	Latvia	2007–2013
Citadele	Lithuania	2004–2013
DNB	Lithuania	2007–2013
Finasta	Lithuania	2008–2013
Medbank	Lithuania	2002–2013
SEB	Lithuania	2005–2013
Siauliu	Lithuania	2006–2013
Swedbank	Lithuania	2003–2013

Table A.1
The list of the banks used in the analysis and data availability for these banks.

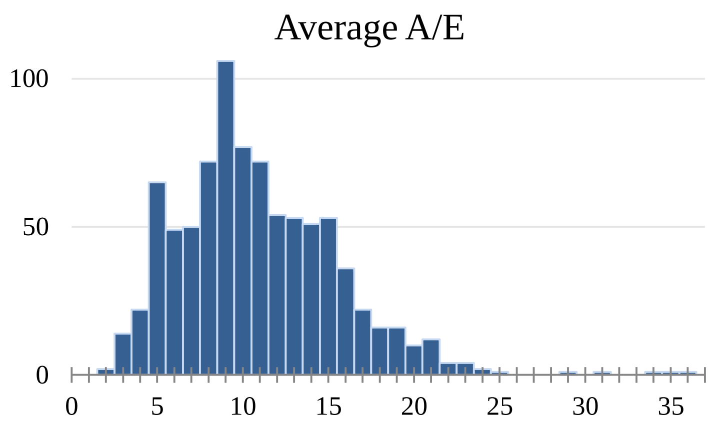

Figure A.1
Distribution of the ratio of average assets-to-equity of the banks from the sample. The number of observations with the ratio of average assets-to-equity within a certain interval are one the y-axis.

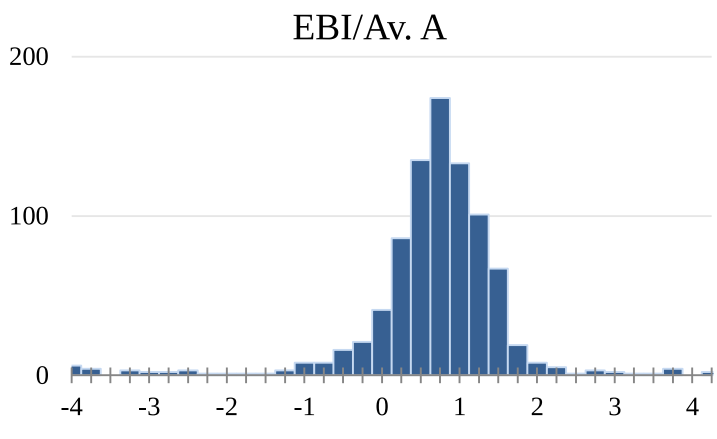

Figure A.2
Distribution of the ratio of earnings before interest expenses to average assets (%) of the banks in the sample. The number of observations with the ratio of earnings before interest expenses to average assets within a certain interval are one the y-axis.

B Regression diagnostics

In order to avoid the spurious regression relationship, we tested our data for stationarity using the Im—Pesaran—Shin unit-root test, including a time trend and choosing the number of lags based on the Akaike information criteria. The results are summarized in table B.1.

Variable	Average lags (chosen by AIC)	Statistics	P-value
$Av.\ \frac{A}{E}$	0.83	−2.3984	0.0082
$\frac{EBI_t}{Av.\ A}$	0.24	−19.0441	0.0000
$\Delta\left(Av.\ \frac{A}{E}\right)$	0.83	−14.2943	0.0000
$\left(\Delta\left(Av.\ \frac{A}{E}\right)\right)^2$	0.59	−9.6592	0.0000
$\Delta\frac{EBI_t}{Av.\ A}$	0.45	−29.3598	0.0000

Table B.1
Im—Pesaran—Shin unit-root test, including a time trend and choosing the number of lags based on the Akaike information criteria. The null-hypothesis is that all panels contain unit roots.

The results suggest that the data is stationary even in levels, with a small probability that the average ratio of assets-to-equity contains unit-root. For the data in difference, however, we can reject the hypothesis that it contains unit-root even at very low levels of significance.

Although residuals of the regression fail statistical tests for normality (skewness/kurtosis, Shapiro—Wilk, and Shapiro—Francia tests reject the null-hypothesis that the data is normally distributed at the levels of significance below 0.01%), their histogram resembles the 'bell-shape' of a normal distribution quite well (figure B.1).

Residuals are also not correlated with the explanatory variables at the significance level of 10% as shown in table B.2.

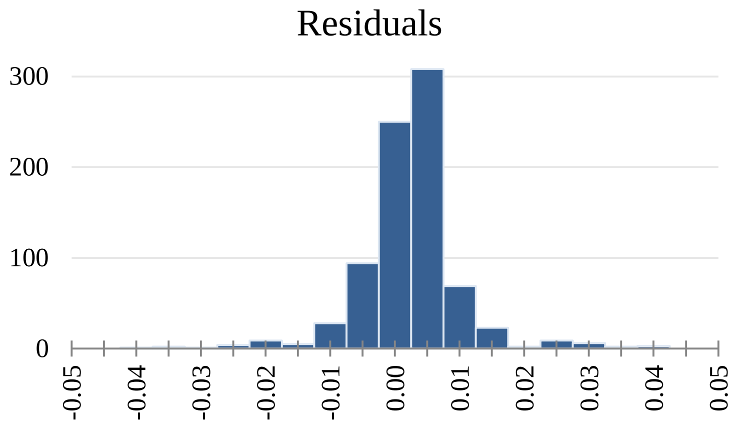

Figure B.1
Distribution of the residuals (ε_{it}) of the regression. The values of the residuals are on the x-axis, the number of observations with the residuals within a certain interval are on the y-axis.

	$\Delta\left(Av.\ \frac{A}{E}\right)$	$\left(\Delta\left(Av.\ \frac{A}{E}\right)\right)^2$	ε_{it}
$\Delta\left(Av.\ \frac{A}{E}\right)$	1.000 —		
$\left(\Delta\left(Av.\ \frac{A}{E}\right)\right)^2$	−0.0543 0.1170	1.0000 —	
ε_{it}	0.0068 0.8456	0.0355 0.3085	1.0000 —

Table B.2
Correlation matrix of the explanatory variables and the error term. P-values are reported under the correlation coefficients.

C Endogeneity problem

The employed specification of a regression might have an endogeneity and collinearity problem, because similar terms appear on the both right and left hand-sights. Because we use the following derivations only for illustration purposes, we omit the quadratic term for simplicity.

$$\Delta \frac{EBI_t}{Av.\,A} = \beta_0 + \beta_1 \Delta \left(Av.\, \frac{A}{E} \right) + \mu_t + \gamma_i + \varepsilon_{it} \tag{C.1}$$

First, let us remind ourselves that EBI is the sum of net profit (NP) and interest expenses (I):

$$EBI_t = NP_t + I_t \tag{C.2}$$

The average assets might be decomposed into assets in the end and in the beginning of the period, while assets in the end of the period can be expressed as assets in the beginning plus changes in equity (ΔE) and debt (ΔD). Changes in equity, however, are composed of net profit and net dividends (Div).

$$Av.\,A = \frac{A_{t-1} + A_t}{2} = \frac{A_{t-1} + (A_{t-1} + \Delta E + \Delta D)}{2} = \frac{A_{t-1} + A_{t-1} + (NP_t + Div_t) + \Delta D}{2} \tag{C.3}$$

Now, let us look at the right hand-sight. The average assets are calculated based on the values of assets and equity in the beginning and in the end of the period, and as it is explained above, values for both of the variables in the end of the period are equal to the values in the beginning of the period plus some changes (equation C.4).

$$\begin{aligned} Av.\,\frac{A}{E} &= \frac{\left(\frac{A}{E}\right)_{t-1} + \left(\frac{A}{E}\right)_t}{2} = \frac{\frac{A_{t-1}}{E_{t-1}} + \frac{A_t}{E_t}}{2} = \frac{\frac{A_{t-1}}{E_{t-1}} + \frac{A_{t-1} + \Delta D + \Delta E}{E_{t-1} + \Delta E}}{2} \\ &= \frac{\frac{A_{t-1}}{E_{t-1}} + \frac{A_{t-1} + \Delta D + NP_t + Div_t}{E_{t-1} + NP_t + Div}}{2} \end{aligned} \tag{C.4}$$

Putting everything together, we get the following

$$\Delta\left(\frac{NP_t + I_t}{\left(\frac{A_{t-1} + A_{t-1} + (NP_t + Div_t) + \Delta D}{2}\right)}\right) = \beta_0 + \beta_1 \Delta\left(\frac{\frac{A_{t-1}}{E_{t-1}} + \frac{A_{t-1} + \Delta D + NP_t + Div_t}{E_{t-1} + NP_t + Div}}{2}\right) + \mu_t + \gamma_i + \varepsilon_{it} \quad \text{(C.5)}$$

A number of terms, which are NP_t and A_{t-1}, appear on the both right and left hand-sights, and in both numerators and denominators. This might be a problem, however, NP_t appears in both denominator and numerator, which might cancel the overall effect of the term; while A_{t-1} appears in the denominator on the left hand-sight and in the numerator on the right hand-sight, which means that there is not linear relationship between them. Thus, it is not clear, whether this might have any implications. Moreover, the situation becomes even more complex, taking into account that both dependant variable and the regressor are taken in differences and that there is also a quadratic term.

In order to make clear whether the described issue threatens the legibility of the results, we did the following checks: firs of all, we specified alternative versions of the regressions, which might have less problems of endogeneity (table C.1), and second of all, we ran a series of Monte-Carlo simulations for hypothetical banks, which WACC behaves according to Modigliani—Miller proposition I.

Regression results of alternative specifications, although being insignificant in most cases, appear to be consistent with the main regression estimates when they are significant, having the same direction of the effect.

For Monte-Carlo experiments we generated 1,000 different simulations with 1,000 observations in each one, assuming that the WACC of a hypothetical bank does not depend on its leverage. The bank in the simulation witnessed the random WACC and return on debt in each period, and return on equity was calculated to be consistent with the WACC. A random part of the net profit for the period was paid out as dividends, the remaining part increased equity in the next period. Debt dynamics were also random, but were generated so that in the longer run the leverage would remain the same. Means of the estimated coefficients together with t-statistics are reported in the table C.2.

Simulation results suggest that none of the coefficients in none of the specifications is significant (it is especially important to notice that these results hold for the second regression version, which is used as the central one in the main analysis). Therefore, there should not be a problem of spurious relationship.

	Fixed effects with quarter dummies $\frac{EBI_t}{Av.A}$	Fixed effects with quarter dummies $\frac{EBI_t}{Av.A}$	Fixed effects with quarter dummies $\frac{EBI_t}{Av.A}$	Fixed effects with quarter dummies $\frac{EBI_t}{Av.A}$
$Av.\frac{A}{E}$	0.000538 −0.82			
$\left(Av.\frac{A}{E}\right)^2$	−0.000028 (−1.55)			
$\Delta\frac{A}{E}$		-0.000524* (−1.75)		
$\left(\Delta\frac{A}{E}\right)^2$		−0.000001 (−0.86)		
$\frac{A}{E}$			−0.000392* −0.85	
$\left(\frac{A}{E}\right)^2$			−0.000012** (−2.24)	
$\left(\frac{A}{E}\right)_{t-1}$				−0.000163 (−0.50)
$\left(\frac{A}{E}\right)^2_{t-1}$				0.000003 −0.69
Intercept	0.001208 (−0.01)	−0.000745 (−0.20)	0.002051 -0.43	−0.000354 (−0.07)
N	863	824	863	863
R^2	0.262	0.141	0.266	0.246

Table C.1
The regression estimates of changes in the proxy for the WACC on changes in the proxy for leverage in various specifications. The average of the dummies for quarters is included in the intercept. T-statistics are in brackets.
*—p-value<0.1, **—p-value<0.05, ***—p-value<0.01

Model	β_0	β_1	β_2
$\frac{EBI_t}{Av.A} = \beta_0 + \beta_1 \left(Av.\frac{A}{E}\right) + \beta_2 \left(Av.\frac{A}{E}\right)^2 + \varepsilon_t$	−0.292848 (−0.03)	0.037891 (0.04)	−0.000826 (−0.03)
$\Delta\frac{EBI_t}{Av.A} = \beta_0 + \beta_1 \Delta\left(Av.\frac{A}{E}\right) + \beta_2 \left(\Delta\left(Av.\frac{A}{E}\right)\right)^2 + \varepsilon_t$	0.005436 (0.03)	−0.003363 (−0.02)	0.000179 (0.02)
$\frac{EBI_t}{A_{t-1}} = \beta_0 + \beta_1 \left(\frac{A}{E}\right)_{t-1} + \beta_2 \left(\left(\frac{A}{E}\right)_{t-1}\right)^2 + \varepsilon_t$	0.023149 (0.13)	−0.000429 (−0.01)	0.000083 (0.05)
$\Delta\frac{EBI_t}{A_{t-1}} = \beta_0 + \beta_1 \Delta\left(\frac{A}{E}\right)_{t-1} + \beta_2 \left(\Delta\left(\frac{A}{E}\right)_{t-1}\right)^2 + \varepsilon_t$	−0.000108 (−0.02)	0.002948 (0.13)	0.000075 (0.05)
$\Delta\frac{EBI_t}{A_{t-1}} = \beta_0 + \beta_1 \Delta\left(\frac{A}{E}\right)_{t} + \beta_2 \left(\Delta\left(\frac{A}{E}\right)_{t}\right)^2 + \varepsilon_t$	0.090019 (0.10)	−0.008899 (−0.06)	0.000297 (0.05)

Table C.2
The results for the estimated coefficients of the Monte-Carlo simulations. Means of 1,000 experiments are reported, and t-statistics are in brackets.

D The pass-through effect of GDP decrease into banks asset value

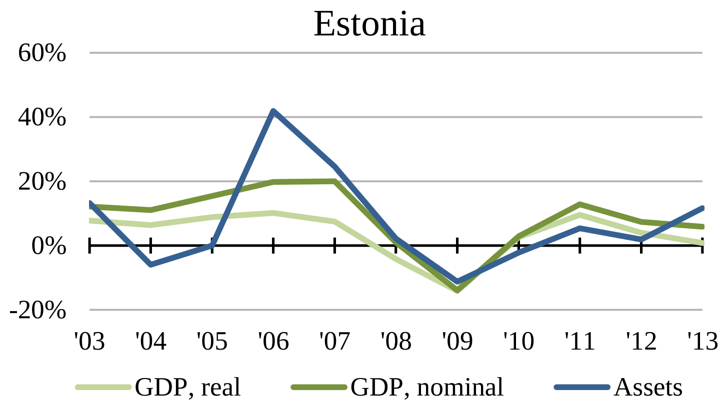

Figure D.1
The growth of banks total assets versus the growth in GDP in nominal and real terms over the 10 year period in Estonia. interval are on the y-axis.
Source: Eurostat (2014), banks' financial statements.

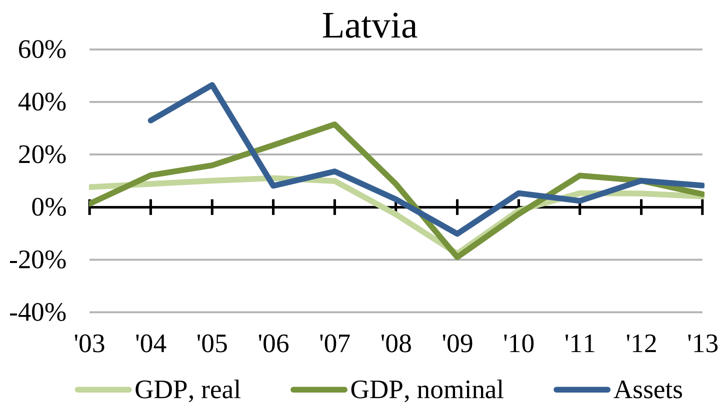

Figure D.2
The growth of banks total assets versus the growth in GDP in nominal and real terms over the 10 year period in Latvia. interval are on the y-axis.
Source: Eurostat (2014), banks' financial statements.

Based on the simple visual check (see figures D.1, D.2, and D.3), we can see that banks' assets growth indeed follows the GDP growth during the downturns, therefore, the assumption about one-to-one transition of the proportional economic declines into the proportional asset decline seems to be quite relevant, though it is slightly less than one-to-one.

Year 2009 is the beginning year of the both economic crisis and decrease in the asset value (see table D.1), and since we in our work looked at the annual GDP distribution, we are not concerned with cumulative GDP and asset falls, thus the following analysis is based

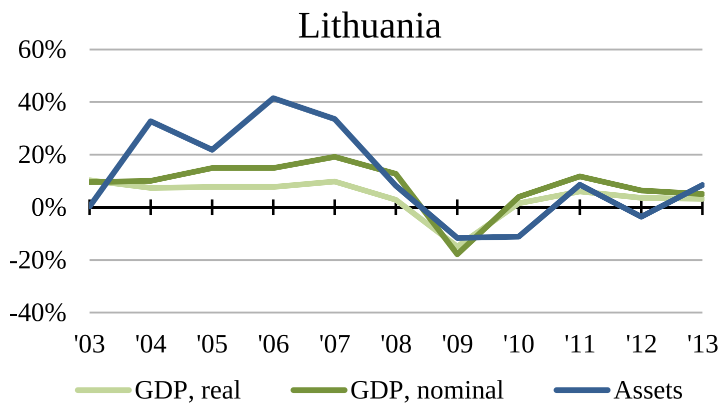

Figure D.3
The growth of banks total assets versus the growth in GDP in nominal and real terms over the 10 year period in Lithuania. interval are on the y-axis.
Source: Eurostat (2014), banks' financial statements.

purely on the year 2009. The pass-through effect (PT) is defined as the change in GDP over the change in assets (equation D.1).

$$PT = \frac{\left(\frac{Y_{2009} - Y_{2008}}{Y_{2008}}\right)}{\left(\frac{A_{2009} - A_{2008}}{A_{2008}}\right)} \tag{D.1}$$

And the weight of the countries assets is calculated as the total assets of the banks in the country divided by the total weights of the banks in the region.

The calculation results suggest that the weighted average of the pass-through effect for the Baltic banks is about 68.94% (see table D.2).

Another important observation is that during the periods of downturns, changes in real GDP are much closer to changes in nominal GDP than during the periods of growth. This reflects the decrease in GDP deflators. Such situation is consistent with economic theory and is, most probably, due to negative output gap and economy operating at below its potential. In case of Latvia and Estonia, GDP deflators for 2009 are less than 0. And the weighted average for the gap between the nominal and real GDP three counties is also less than zero (see table D.3). The gap is defined as the difference between nominal GDP growth rate and the real GDP growth rate, and the results are weighted by the real GDP size, because our initial GDP growth distribution is also in real terms.

The calculation results (see table D.3) suggest that inflation during the downturn periods is negative and equal to −1.76%.

	Estonia			Latvia			Lithuania		
Year	Assets	Nominal GDP	Real GDP	Assets	Nominal GDP	Real GDP	Assets	Nominal GDP	Real GDP
2003	13.27	12.12	7.77	0.00	1.29	7.66	0.30	9.54	10.28
2004	−6.02	11.08	6.34	32.99	12.19	8.83	32.77	10.07	7.37
2005	−0.05	15.45	8.85	46.50	15.90	10.10	21.86	14.93	7.79
2006	41.88	19.76	10.10	8.16	23.62	10.99	41.52	14.95	7.81
2007	24.58	20.00	7.49	13.54	31.56	9.99	33.55	19.23	9.80
2008	2.20	1.03	−4.15	2.99	8.86	−2.77	8.23	12.79	2.91
2009	**−11.28**	**−13.95**	**−14.10**	**−10.13**	**−19.08**	**−17.70**	**−11.66**	**−17.77**	**−14.85**
2010	−2.18	2.87	2.57	5.28	−2.60	−1.31	−11.08	3.96	1.60
2011	5.37	12.84	9.56	2.36	12.04	5.31	8.55	11.72	6.05
2012	1.90	7.39	3.94	10.08	10.12	5.22	−3.52	6.40	3.66
2013	11.62	5.85	0.83	8.23	5.01	4.11	8.54	5.04	3.25

Table D.1
GDP and asset value growth rates (%) in the Baltic countries between 2003 and 2013. Year when all variables experienced a fall is in bold.
Source: Eurostat (2014), banks' financial statements.

Country	GDP growth to asset growth pass-through	Weight of countries' assets	Weighted pass-through
Estonia	0.7998	0.1223	0.0978
Latvia	0.5723	0.4586	0.2624
Lithuania	0.7853	0.4191	0.3291
Sum			0.6894

Table D.2
The pass-through of GDP decrease into asset value decrease of the Baltic banks in 2009, and the weighted average of this pass-through.
Source: Eurostat (2014), banks' financial statements.

Country	Gap between nominal and real GDP growth, %	Real GDP weight	Weighted gap, %
Estonia	0.1446	0.2407	0.0348
Latvia	−1.3855	0.2789	−0.3864
Lithuania	−2.9227	0.4804	−1.4041
Sum			−1.7558

Table D.3
The gap between the nominal GDP growth and the real GDP growth for the three Baltic countries in 2009. The average is weighted according to the size of real GDP in 2009.
Source: Eurostat (2014).

E Sensitivity of sample

In order to understand how sample specific our results were, we also ran two regressions for two different times periods: before the crisis in 2008 and after it.

	Fixed effects with quarter dummies, 2002–2008 $\Delta\frac{EBI_t}{Av.A}$	Fixed effects with quarter dummies, 2008–2013 $\Delta\frac{EBI_t}{Av.A}$
$\Delta\left(Av.\frac{A}{E}\right)$	−0.000539** (−2.53)	−0.000770* (−2.03)
$\left(\Delta\left(Av.\frac{A}{E}\right)\right)^2$	−0.000139* (−1.45)	−0.000089** (−13.61)
Intercept	−0.000586 (−0.25)	(−0.000615) (−0.21)
N	276	548
R^2	0.18	0.14

Table E.1
The results of using central regression on two sub-samples.

As shown in table E.1, alternative specifications suggest that the sign and the approximate size of the effect is time-period specific. However, the exact numbers differ, and we can reject the hypothesis that they are equal at all reasonable significance level (t-statistics for Welch's t-test are 10.06 and −8.64 for the linear and the square terms respectively). In order to address this issue, we performed an analysis of how this affects net benefits of the increase in the capital requirements in appendix F, and with both of the values for each of the explanatory variables the final number remains almost the same.

F Sensitivity of inputs

For the sensitivity analysis purposes we were changing the levels of the initial CAR together with each of the following variables:

- the changes in the CAR;
- the ratio of risk-weighted to total assets (*const*);
- inflation (π);
- social discount rate (d);
- the estimated linear coefficient of the responsiveness of changes in the WACC to changes in leverage ($\hat{\beta}_1$);
- the estimated quadratic coefficient of the responsiveness of changes in the WACC to changes in leverage ($\hat{\beta}_2$);
- the elasticity of output with respect to capital (α);
- the elasticity of substitution between capital and labour (σ);
- the size of the pass-through of the falls in GDP into falls in asset values (PT);
- cost of crisis (CoC).

We decided to add the current CAR level to each of the analyses, because over the last crisis, banks injected significant amounts of equity in order to be able to bear the losses, and it is not clear whether they will maintain or decrease the same equity levels, because the economic situation stabilised and improves.

The results are in the tables F.1–F.10.

ΔCAR, pp.	Current CAR, %									
	8	9	10	11	12	13	14	15	16	17
1	4.23	2.85	3.11	3.78	1.96	1.03	0.69	0.63	1.17	0.17
2	8.07	6.61	7.34	6.06	3.22	1.88	1.44	1.90	1.42	1.38
3	12.65	11.38	9.99	7.58	4.27	2.79	2.83	2.24	2.70	1.15
4	18.10	14.49	11.83	8.87	5.35	4.31	3.27	3.60	2.53	2.53
5	21.78	16.73	13.40	10.15	7.02	4.86	4.71	3.50	3.97	2.90
6	24.52	18.64	14.93	12.00	7.70	6.41	4.70	5.00	4.39	3.16
7	26.85	20.47	16.99	12.84	9.37	6.49	6.27	5.48	4.70	3.61
8	29.05	22.79	18.03	14.66	9.56	8.15	6.82	5.84	5.19	3.64
9	31.70	24.06	20.01	14.97	11.32	8.77	7.24	6.38	5.26	4.00
10	33.27	26.26	20.48	16.85	12.03	9.26	7.84	6.49	5.65	4.37

Table F.1
The net effect of the increases in CAR, given different levels of increases in CAR (column) and different current levels of CAR (row). Net benefits are in percentages of GDP.

$\frac{RWA}{A}$, %	Current CAR, %									
	8	9	10	11	12	13	14	15	16	17
0.1	122.60	78.08	50.62	37.09	28.13	22.24	15.70	12.32	10.28	11.27
0.2	37.29	26.42	17.97	14.38	12.89	11.29	8.40	10.20	8.91	10.32
0.3	23.19	18.03	16.25	15.24	10.51	7.99	8.35	9.23	7.22	4.15
0.4	20.67	14.56	13.02	11.06	9.12	7.26	5.89	4.54	3.94	4.87
0.5	15.89	14.05	9.38	7.33	5.82	5.71	6.36	6.39	5.18	3.19
0.6	14.39	9.84	7.34	8.15	7.75	6.73	4.02	2.66	1.90	1.74
0.7	10.30	8.54	9.05	7.59	4.60	2.05	2.08	1.94	1.79	1.61
0.8	10.48	9.59	6.77	3.49	2.95	1.93	2.41	1.65	2.09	1.29
0.9	10.26	6.83	3.41	3.04	2.35	2.08	2.25	1.48	1.76	0.79
1	7.92	3.75	2.95	3.19	1.72	2.21	1.30	0.82	0.48	0.73

Table F.2
The net effect of the increases in CAR, given different values of the ratio of the risk-weighted assets to total assets (column) and different current levels of CAR (row). Net benefits are in percentages of GDP.

π, %	Current CAR, %									
	8	9	10	11	12	13	14	15	16	17
−5	1.24	1.35	1.10	1.03	0.80	0.86	0.59	0.90	−0.02	0.26
−4	4.16	1.20	1.72	1.19	1.26	1.01	1.05	0.90	1.05	0.11
−3	6.46	4.27	1.72	2.11	1.41	1.47	1.05	1.37	0.90	1.18
−2	9.07	6.57	4.02	1.80	2.03	1.78	1.81	1.21	1.66	1.03
−1	9.22	9.18	6.63	4.10	2.03	2.24	1.97	1.98	1.36	1.95
0	10.60	9.33	8.93	6.56	4.18	2.24	2.43	2.13	2.12	1.33
1	11.67	10.56	9.85	9.01	6.94	4.23	2.12	2.59	2.28	2.25
2	19.65	12.24	10.77	10.08	9.39	7.15	4.11	2.59	2.74	2.56
3	24.10	19.46	12.76	11.01	10.01	9.60	6.88	3.97	2.74	2.71
4	32.39	24.98	19.67	12.69	11.23	10.52	10.10	7.04	4.12	3.02

Table F.3
The net effect of the increases in CAR, given different values of inflation (column) and different current levels of CAR (row). Net benefits are in percentages of GDP.

d, %	Current CAR, %									
	8	9	10	11	12	13	14	15	16	17
0.5	53.00	46.65	44.64	32.78	20.88	11.19	12.13	10.66	10.62	6.66
1.0	26.50	23.32	22.32	16.39	10.44	5.60	6.07	5.33	5.31	3.33
1.5	17.67	15.55	14.88	10.93	6.96	3.73	4.04	3.55	3.54	2.22
2.0	13.25	11.66	11.16	8.19	5.22	2.80	3.03	2.67	2.66	1.67
2.5	10.60	9.33	8.93	6.56	4.18	2.24	2.43	2.13	2.12	1.33
3.0	8.83	7.77	7.44	5.46	3.48	1.87	2.02	1.78	1.77	1.11
3.5	7.57	6.66	6.38	4.68	2.98	1.60	1.73	1.52	1.52	0.95
4.0	6.63	5.83	5.58	4.10	2.61	1.40	1.52	1.33	1.33	0.83
4.5	5.89	5.18	4.96	3.64	2.32	1.24	1.35	1.18	1.18	0.74
5.0	5.30	4.66	4.46	3.28	2.09	1.12	1.21	1.07	1.06	0.67

Table F.4
The net effect of the increases in CAR, given different values of social discount rate (column) and different current levels of CAR (row). Net benefits are in percentages of GDP.

$\hat{\beta}_1$	Current *CAR*, %									
	8	9	10	11	12	13	14	15	16	17
−0.0010	8.09	7.29	7.24	5.13	2.96	1.19	1.51	1.33	1.41	0.70
−0.0009	8.91	7.96	7.79	5.60	3.36	1.54	1.81	1.59	1.65	0.90
−0.0008	9.74	8.63	8.35	6.07	3.76	1.88	2.11	1.86	1.88	1.11
−0.0007	10.57	9.30	8.91	6.54	4.16	2.22	2.41	2.12	2.12	1.32
−0.0006	11.40	9.97	9.46	7.01	4.56	2.57	2.72	2.39	2.35	1.53
−0.0005	12.22	10.65	10.02	7.47	4.96	2.91	3.02	2.65	2.58	1.74
−0.0004	13.05	11.32	10.57	7.94	5.36	3.26	3.32	2.92	2.82	1.95
−0.0003	13.88	11.99	11.13	8.41	5.76	3.60	3.62	3.18	3.05	2.16
−0.0002	14.70	12.66	11.69	8.88	6.16	3.95	3.92	3.45	3.29	2.37
−0.0001	15.53	13.33	12.24	9.35	6.56	4.29	4.22	3.71	3.52	2.58

Table F.5
The net effect of the increases in CAR, given different values of the estimated linear coefficient of the responsiveness of changes in the WACC to changes in leverage (column) and different current levels of CAR (row). Net benefits are in percentages of GDP.

$\hat{\beta}_2$	Current *CAR*, %									
	8	9	10	11	12	13	14	15	16	17
−0.00010	11.1655	9.7015	9.1828	6.7365	4.3082	2.3368	2.5011	2.1900	2.1703	1.3689
−0.00009	10.8233	9.4760	9.0283	6.6270	4.2284	2.2773	2.4558	2.1550	2.1427	1.3469
−0.00008	10.4810	9.2506	8.8737	6.5175	4.1486	2.2178	2.4106	2.1199	2.1152	1.3249
−0.00007	10.1388	9.0252	8.7192	6.4080	4.0689	2.1583	2.3653	2.0849	2.0876	1.3029
−0.00006	9.7966	8.7998	8.5646	6.2985	3.9891	2.0989	2.3201	2.0498	2.0600	1.2810
−0.00005	9.4543	8.5743	8.4100	6.1890	3.9094	2.0394	2.2748	2.0148	2.0325	1.2590
−0.00004	9.1121	8.3489	8.2555	6.0795	3.8296	1.9799	2.2296	1.9797	2.0049	1.2370
−0.00003	8.7698	8.1235	8.1009	5.9699	3.7498	1.9204	2.1843	1.9447	1.9773	1.2150
−0.00002	8.4276	7.8980	7.9464	5.8604	3.6701	1.8609	2.1391	1.9096	1.9498	1.1931
−0.00001	8.0853	7.6726	7.7918	5.7509	3.5903	1.8015	2.0938	1.8746	1.9222	1.1711

Table F.6
The net effect of the increases in CAR, given different values of the estimated quadratic coefficient of the responsiveness of changes in the WACC to changes in leverage (column) and different current levels of CAR (row). Net benefits are in percentages of GDP.

α	Current *CAR*, %									
	8	9	10	11	12	13	14	15	16	17
0.1	12.86	11.50	10.93	8.38	5.82	3.72	3.76	3.34	3.22	2.32
0.2	12.05	10.73	10.22	7.73	5.23	3.19	3.28	2.91	2.83	1.97
0.3	11.02	9.73	9.30	6.89	4.48	2.51	2.67	2.35	2.33	1.51
0.4	9.63	8.40	8.07	5.77	3.47	1.60	1.85	1.62	1.66	0.91
0.5	7.70	6.54	6.35	4.21	2.06	0.33	0.71	0.58	0.72	0.06
0.6	4.80	3.75	3.77	1.87	−0.05	−1.57	−1.01	−0.97	−0.68	−1.22
0.7	−0.03	−0.90	−0.53	−2.03	−3.57	−4.74	−3.87	−3.55	−3.02	−3.34
0.8	−9.70	−10.21	−9.13	−9.84	−10.62	−11.09	−9.59	−8.72	−7.70	−7.60
0.9	−38.71	−38.12	−34.92	−33.27	−31.76	−30.13	−26.75	−24.22	−21.74	−20.35

Table F.7
The net effect of the increases in CAR, given different values of the elasticity of output with respect to capital (column) and different current levels of CAR (row). Net benefits are in percentages of GDP.

σ	Current *CAR*, %									
	8	9	10	11	12	13	14	15	16	17
0.5	12.05	10.73	10.22	7.73	5.23	3.19	3.28	2.91	2.83	1.97
0.6	11.76	10.45	9.96	7.49	5.02	3.00	3.11	2.75	2.69	1.84
0.7	11.47	10.17	9.70	7.26	4.81	2.81	2.94	2.60	2.55	1.72
0.8	11.18	9.89	9.44	7.02	4.60	2.62	2.77	2.44	2.41	1.59
0.9	10.89	9.61	9.19	6.79	4.39	2.43	2.60	2.29	2.27	1.46
1.0	10.60	9.33	8.93	6.56	4.18	2.24	2.43	2.13	2.12	1.33
1.1	10.31	9.05	8.67	6.32	3.97	2.05	2.25	1.98	1.98	1.21
1.2	10.02	8.77	8.41	6.09	3.75	1.86	2.08	1.82	1.84	1.08
1.3	9.73	8.49	8.15	5.85	3.54	1.67	1.91	1.67	1.70	0.95
1.4	9.44	8.21	7.90	5.62	3.33	1.48	1.74	1.51	1.56	0.82

Table F.8
The net effect of the increases in CAR, given different values of the elasticity of substitution between capital and labour (column) and different current levels of CAR (row). Net benefits are in percentages of GDP.

PT	Current *CAR*, %									
	8	9	10	11	12	13	14	15	16	17
0.3	1.55	−0.18	−0.12	−0.35	−0.73	−0.83	−0.95	−0.94	−0.94	−0.51
0.4	3.08	2.43	1.72	0.88	−0.12	−0.22	−0.03	0.14	−0.02	−0.51
0.5	8.45	3.50	2.79	2.72	1.11	1.78	0.89	0.29	0.13	0.11
0.6	11.21	9.02	6.01	2.26	2.64	2.09	2.12	1.06	1.36	1.18
0.7	10.45	9.02	9.54	7.32	4.94	2.09	2.43	2.13	1.97	1.64
0.8	11.98	9.48	7.24	8.86	8.17	5.15	3.50	2.13	1.97	1.95
0.9	14.90	11.17	8.47	6.56	7.25	7.46	7.34	4.43	3.05	2.10
1.0	15.51	13.93	10.62	8.40	6.78	5.92	6.88	7.35	6.27	3.94
1.1	15.66	13.78	12.92	9.93	8.01	7.15	5.03	5.97	6.42	6.24
1.2	18.73	14.39	12.61	11.31	8.93	7.92	5.80	4.89	5.50	6.09

Table F.9
The net effect of the increases in CAR, given different values of the pass-through of the GDP falls to asset value decreases (column) and different current levels of CAR (row). Net benefits are in percentages of GDP.

CoC, %	Current *CAR*, %									
	8	9	10	11	12	13	14	15	16	17
10	1.30	0.98	1.01	0.43	−0.15	−0.61	−0.43	−0.40	−0.30	−0.46
20	5.51	4.76	4.59	3.20	1.80	0.68	0.86	0.74	0.79	0.35
30	9.72	8.54	8.17	5.97	3.76	1.97	2.15	1.89	1.89	1.16
40	13.92	12.31	11.76	8.74	5.72	3.26	3.45	3.04	2.99	1.97
50	18.13	16.09	15.34	11.52	7.68	4.55	4.74	4.18	4.09	2.79
60	22.33	19.86	18.93	14.29	9.64	5.84	6.03	5.33	5.19	3.60
70	26.54	23.64	22.51	17.06	11.60	7.13	7.32	6.48	6.29	4.41
80	30.74	27.41	26.09	19.83	13.56	8.42	8.61	7.63	7.39	5.22
90	34.95	31.19	29.68	22.60	15.52	9.71	9.90	8.77	8.49	6.04
100	39.15	34.96	33.26	25.38	17.48	11.00	11.19	9.92	9.59	6.85

Table F.10
The net effect of the increases in CAR, given different values of the cost of crisis expressed as percentages of GDP (column) and different current levels of CAR (row). Net benefits are in percentages of GDP.

G Notation

Notation	Explanation
A	Total assets
$Av.A$	Average total assets for the period
B	Benefits of the regulation
C	Costs of the regulation
CAR_{II}	Capital adequacy ratio under Basel II
CAR_{III}	Capital adequacy ration under Basel III
CAR	Capital adequacy ratio
CoC	Cost of crisis
$const$	Ratio of the risk-weighted to total assets
d	Social discount rate
D	Total liabilities
E	Total equity
EBI	Earnings before interest expenses
I	Interest expenses
K	Capital
L	Labour
MPK	Marginal productivity of capital
NP	Net profit
$\Pr Cr$	Probability of crisis
P_K	Price of capital
P_L	Price of labour
PV	Present values
r_f	Risk-free rate
R_P	Market risk-premium according to CAPM
RWA	Risk-weighted assets
$threshold$	GDP fall used for calculation of the probability of crisis
Y	Output, GDP
i	Interest rates in the economy
α	Elasticity of output with respect to capital
β_{assets}	A measure of a firm's assets systemic risk, according to CAPM
β_{equity}	A measure of a firm's equity systemic risk, according to CAPM
γ_i	Entity-fixed effects
δ	Depreciation rate of capital in the economy
μ_t	Time-fixed effects
σ	Elasticity of substitution between capital and labour

Table G.1
List of notations used in the work