Quantifying the Impact of Higher Capital Requirements on the Swiss Economy

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JEL-Classification: G21, G28
Keywords: Capital regulation, banks, cost of equity, banking crisis, economic growth, Modigliani-Miller.

1. Introduction

The purpose of this paper is to quantify the long-run social costs and benefits of higher capital requirements resulting from the revised Basel Capital Accord (Basel III)[1] and the Swiss Too Big To Fail (TBTF) regulations.[2] The social costs of higher capital requirements are reflected in increased lending spreads and potential output reductions. The social benefits come from the potential reduction of banking crises and expected GDP losses associated with such crises. So far the debate in Switzerland about the impact of higher capital requirements has been mainly qualitative. Indeed, in its impact analysis the Swiss TBTF regulatory assessment report (*Regulierungsfolgenabschätzung*)[3] does not provide own

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We are grateful to Alain Schönenberger for earlier collaborative work and to Benjamin Junge for comments on preliminary results and the estimation of equity betas. Moreover, we thank Niklaus Blattner, Petra Gerlach, Yvan Lengwiler Thomas Nitschka, Burkhard Poschadel, Tobias Straumann and seminar participants from FINMA and SNB for useful comments and discussions. Moreover, helpful comments of anonymous referees are gratefully acknowledged.

1 In December 2010 the Basel Committee for Banking Supervision released its comprehensive new regulatory framework that addresses the lessons learnt from the 2007 financial crisis. The package is known as Basel III (see BIS (December 2010 (rev June 2011).

2 Expertenkommission (30. September 2010), Schlussbericht der Expertenkommission zur Limitierung von volkswirtschaftlichen Risiken durch Grossunternehmen.

3 Regulierungsgsfolgenabschätzung (March 2011) zur Änderung des Bankengesetzes (too big to fail).

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estimates based on Swiss empirical evidence but refers to estimates from the Basel Committee for Banking Supervision (BCBS) and the Institute of International Finance (IIF), which represents the banking industry. Only a recently published FINMA consultation paper (October 2011)[4] goes a step further and estimates the impact of increased capital requirements on the Swiss banking sector excluding the two large Swiss banks.[5] The result is that the bulk of the Swiss banks already meet the Basel III capital requirements. Only the two large Swiss banks face a capital shortfall of an unspecified amount. Reiterating the comfortable capital situation of the Swiss non-large banks, the FINMA consultation paper concludes that the economic costs of the higher capital requirements will be rather small in comparison to the expected social benefits. That notwithstanding, in a recently published report the IIF claims that the economic impact of the regulatory reforms in terms of forgone real GDP and employment will be substantial.[6]

This paper is an attempt to move the Swiss debate from a qualitative analysis to a quantitative assessment of higher capital requirements. In view of the high economic importance of the banking sector for Switzerland, we believe it is worthwhile to deepen the debate and to provide a quantitative view of the costs and benefits of the new regulations. Naturally the focus will be on the two large Swiss banks because they are of critical importance for Switzerland and the centerpiece of the TBTF and the new Basel III regulations in Switzerland.

Our estimations are intended to be broadly right, offering orders of magnitude rather than exact point estimates. The approach relies on first principles of corporate finance and economic growth theory and applies standard econometric techniques. It includes estimating to what extent the risk-return profile of banks and the funding structure changes in response to higher capital requirements and calculates the corresponding long-run GDP costs. In order to identify the benefits of higher capital levels we first estimate the economic costs of banking crises using Swiss data and next calculate the expected benefits of reducing the annual probability of banking crises.

In interpreting our findings it is important to note that we estimate only the social costs and benefits of higher capital requirements and do not include other aspects of the Basel III financial reform and the Swiss TBTF legislation. For example, costs and benefits resulting from enhanced liquidity standards are not included in our calculations, nor is the impact of stricter risk management and

4 FINMA Erläuterungsbericht (October 21, 2011).

5 The two large banks are Credit Suisse Group (CSG) and UBS AG (UBS).

6 Institute of International Finance (IIF September 2011), "The Cumulative Impact on the Global Economy of Changes in the Financial Regulatory Framework".

governance standards, as well as the effect of recovery and resolution measures to maintain systemically important functions in response to the failure of large financial institutions. Likewise, we do not take into account explicit and implicit government guarantees and the resultant lower borrowing costs enjoyed by the large banks deemed "too big to fail". These issues, as well as the important transition costs associated with the imposition of higher capital levels, are not covered in this paper. Rather, we focus on two long-run steady states: one prior and one subsequent to the implementation of higher capital levels.

Our results suggest that the long-run social costs of substantially higher capital requirements are likely to be negligible or non-existent. Three reasons may help to explain this result. First, higher capital levels reduce the riskiness of a bank and therefore lower the expected returns required by equity and debt holders. Second, a majority of the Swiss banks already meet the Basel III capital requirements and, given the fierce competition in the Swiss banking market, it is unlikely that the large banks will be able to pass on increases in their cost of capital to the economy as a whole. Third, even if the large banks were able to impose higher lending spreads on their customers, the overall impact on the economy would remain small because of the large banks' moderate share in domestic lending and their low weight in Swiss companies' total external financing. The combination of these factors leads to a minor increase of the capital costs of the nonfinancial sector of 0.6 to 1.5 basis points and a minor permanent annual GDP loss of 0.04 to 0.05%. This is in sharp contrast to the IIF findings, which suggests that the financial reforms under Basel III will lead to a 2.9% reduction in the level of real GDP by 2020, implying an annual GDP decline of 0.3%.

Many empirical studies consider only the social costs of higher capital requirements and thus fail to present a completely fair comparison between costs and benefits. Often this is due to data constraints. Fortunately for Switzerland, there are banking statistics going back to 1881 that can be used to estimate the benefits of higher capital requirements. Our estimates show that the long-run social benefits of substantially higher capital requirements are large and are far greater than the social costs. The increase of capital levels as foreseen by Basel III and the Swiss Too Big to Fail (TBTF) regulations will accordingly reduce the probability of systemic crisis by 3.6% and yield an expected permanent annual GDP benefit of 0.64%. Thus, social benefits exceed social costs by a factor of nearly 11. Even if we take into account that the cost-benefit calculations are subject to estimation errors, the sheer difference between social costs and benefits is huge and should be recognized in the debate about the costs and benefits of the new regulations in Switzerland.

With the exception of the IIF cost calculations our findings are broadly in line with estimates performed for other countries. ELLIOT (2009)[7] and KASHYAP, STEIN and HANSEN (2010)[8] use data on US banks and find that costs of substantially higher capital requirements are rather modest. MILES, YANG and MARCHEGGIANO (2011) perform cost and benefit calculations on UK data and conclude that marginal benefits exceed marginal costs up to an equity capital level of 20% of risk weighted assets (RWA) for UK banks.[9] The social costs resulting from a 50% reduction of leverage are estimated to amount to 0.15%, or 3% of GDP if a discount rate of 5% is applied. Based on a survey of a large number of empirical studies of banking crises, the Basel Committee for Banking Supervision (BCBS)[10] finds that expected benefits of substantially higher capital requirements (raising the CET1 capital ratio by 100%) amount to GDP benefits of 5.84% assuming a discount factor of 5%. Using the same discount factor, the corresponding estimates for Switzerland yield social costs of nearly 1% of GDP and social benefits of 12.7% of GDP[11]. The differences between our estimates for Switzerland and the estimates relating to other countries are quite plausible. Since the majority of the Swiss banks already meet the Basel II standards we expect the social costs of higher capital requirements to be lower than in other countries. On the other hand given the importance of the banking sector for the Swiss economy,[12] it is not surprising that the benefits[13] of higher capital requirements are larger than in other countries. Our ultimate conclusion is that Swiss regulatory authorities would be well advised to implement the target capital ratios of Basel III and the Swiss TBTF legislation without any watering-down.

The article comprises six main sections. Section 2 contains a short review of the definition and size of the new capital ratios under Basel III and the Swiss TBTF legislation. It includes a reference to Annex 1 which provides a more comprehensive picture of the capital ratios under alternative regulatory regimes. Section 3

7 ELLIOT (2009), and ELLIOTT, SALLOY, and SANTOS (2012).

8 See KASHYAP, STEIN and HANSON (2010),

9 There is a growing interest in the research of socially-optimal capital ratios. A study of the Swedish Riksbank concludes that equity capital ratios of 10%-17% of RWAs are socially appropriate. See Sveriges Riksbank (December 2011).

10 See BIS (August 2010), Table 8.

11 We use the discount rate of 5% only in order to compare our results with other studies. The appropriate social discount factor for Switzerland should be much lower.

12 The economic contribution of the financial sector to GDP was 8.3% in 2006 and 6.2% in 2011.

13 Note that the benefits of higher capital requirements consist of the reduction in expected cost of future financial crises.

takes a historical perspective and presents stylized facts about bank leverage, GDP growth and interest rate spreads for Switzerland. Section 4 first describes the econometric framework and then presents the estimates of the cost of capital taking into account modern corporate finance. The two subsections 4.4 and 4.5 translate the econometric findings into changes in bank funding costs and in GDP. For the latter we estimated a production function with constant elasticity of substitution, which is presented in Annex 2. Section 5 addresses the expected social benefits of higher capital levels and estimates first, the output loss resulting from banking crises, and second, the reduction in the annual probability of crises. This section also includes a few comments on the countercyclical buffer, which is more a byproduct of our differentiation between trend and cyclical components of leverage. Finally, section 7 provides a short summary of the costs and benefits of higher capital requirements.

2. Capital Requirements of Basel III and the Swiss TBTF Legislation

In this section we summarize the key elements of the Basel III and the Swiss TBTF regulations, with the focus on capital requirements. In the process, we briefly touch on the financial crisis of 2007 that sparked off the recent wave of regulatory reforms.

There are many explanations for the 2007 financial crisis. The fact is that the capital ratios of the banks, i.e. the relationship between the eligible regulatory capital and risk weighted assets (RWA), were too low to bear the losses of the banks. The low capital ratios resulted from two failures on the part of the banks:

- an inappropriate measurement of risk in certain asset classes as reflected in unreliable RWAs which were set too low, and
- a lack of high quality (loss-absorbing) regulatory capital.

In a first response to these failures, national and international regulators raised the risk weights for selected asset classes. These measures are known as Basel 2.5 and include among other things the introduction of stressed Value-at-Risk and higher capital charges for credit positions, including re-securitisation in both the banking and trading books.[14] The other string of measures focused on

14 BIS (July 2009): "Enhancements to the Basel II Framework and Revision to the Basel II Market Risk Framework" FINMA insisted on a rapid implementation of these measures for banks in

counterparty credit exposures arising from banks' derivatives, repo and securities financing exposures. This reform is part of the Basel III regulatory package and takes two directions. First, it is aimed at curbing the (bilateral) derivative business between banks by significantly[15] raising the capital requirements. And second, it should prepare the way for the establishment of central counterparties and exchanges in order to shift parts of the derivative business away from the banks and into well regulated exchanges.

The crisis has also shown that many banks were heavily undercapitalized with equity capital. In December 2010[16] the member states of the BCBS agreed on a new capital definition and higher capital ratios. The heart of the new definition is Common Equity Tier 1 capital (CET1). It is defined as common shares plus retained earnings and other comprehensive income net of regulatory filters and deductions. Applied to RWAs, the BCBS is now requiring a CET1 capital ratio of at least of 7% of the RWA figure. This consists of two parts: the Minimum Requirement of 4.5% of RWAs and the Capital Conservation Buffer of 2.5% of RWAs. In addition, in periods of excessive aggregate credit growth, regulators can introduce a Countercyclical Buffer amounting to a maximum of 2.5% of the RWAs. Figure 1 illustrates these changes. The new definitions apply to all banks in Switzerland including the two large banks CSG and UBS. However the large banks are in addition subject to the Swiss TBTF regulation.

It is worth emphasizing that the new capital standards will not be introduced at once but are going to be phased in between January 2013 and January 2018. This way the banking sector will not be confronted with abrupt changes and can adapt to the higher capital standards through the natural accumulation of earnings retention, issuance of capital and adjustments of their business models,[17]

Switzerland starting with January 2011. The RWA-impact of Basel 2.5 is significant as can be seen from the 2011 quarterly reports of the two large banks. Credit Suisse experienced an increase in total RWA of about 17% and UBS of about 35%.

15 See BCBS (December 16 2010): Results of the comprehensive quantitative impact study. Accordingly, counterparty credit risk could rise on average by 11% of the total RWA for Group 1 banks, page 14. Group 1 banks are defined as having Tier 1 capital in excess of €3 billion, are well diversified, and are internationally active.

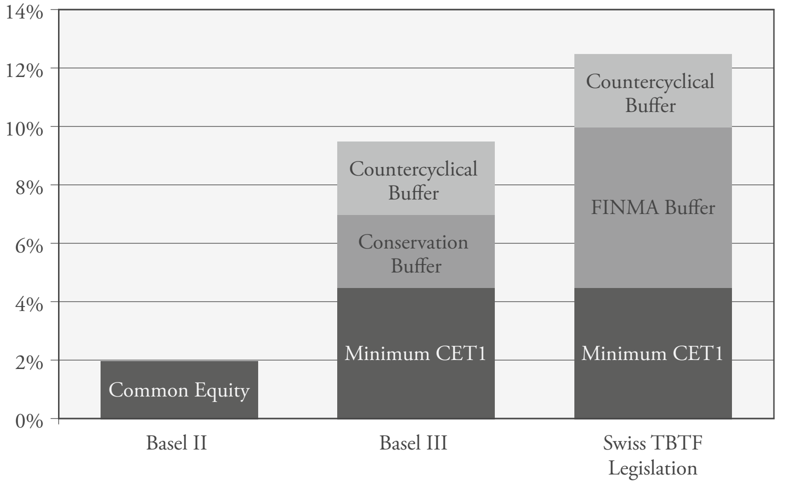
16 BIS (December 2010 (rev. June 2011)). See Definition of Capital.

17 There is a wide spectrum of measures by which banks can respond to higher capital requirements. These include a withdrawal from certain businesses (e.g. proprietary trading, shifting of OTC business to central counterparties), enlarged risk mitigating actions (e.g. improved hedging of capital-intensive portfolios, improving risk and capital models, balance sheet optimization), and enhanced operational efficiencies (e.g. improvements in IT systems, revision of compensation framework), among other things. Investors and creditors will also be willing to lower their required returns to reflect the lower riskiness of the banks. Elliot (2009)

most likely without constraining the banks' lending activities. In fact, this process has already started, as shown by the announced intentions of the banks to reduce risks and adapt their business models.

Figure 1 also shows the new CET1 capital ratios for the two large Swiss banks, excluding other capital instruments described as contingent capital (Wandlungskapital) under the Swiss TBTF regulation. CET1 capital is defined as under Basel III with a Minimum Requirement of 4.5% of RWAs. However, in contrast to the other banks, the two large Swiss banks must hold an additional 8.5% of RWAs as Buffer Capital. The first 5.5% must be common equity and the remaining 3% can be in the form of Convertible Capital (not shown in Figure 1). Thus, the total CET1 capital ratio is 10% of RWAs for two large Swiss banks, which can be augmented by another 2.5%, if the Countercyclical Buffer is activated. A more comprehensive illustration of the new requirements including the other capital instruments than CET1 capital is provided in Annex 1.

Figure 1: CET1 Capital Ratios under Alternative Regulatory Regimes



discusses a combination of actions banks could pursue in response to the regulatory changes. McKinsey&Company (September 2011) presents in detail how banks may adjust to the Basel III regulatory requirements. Note also that the two large Swiss banks benefit from the implicit TBTF government guarantee estimated to be 29 basis points in comparison to the other Swiss banks during the period 2000 to 2007 (Regulierungsfolgenabschätzung, March 2011, p. 64). With the new regulation part of this benefit will be eliminated, but some of it is likely to remain and provides additional scope for adjustment.

In conclusion the minimum regulatory capital ratios increase significantly for Swiss banks under Basel III and the TBTF regulation. First, RWA, the denominator of the capital ratio, increases for selected asset classes (under Basel 2.5 and Basel III). Second, the CET1-based capital ratio is lifted from today's 2% to 7% for all banks and to 10% for large banks located in Switzerland. It can rise further by another 2.5% in times of excessive credit growth, if the Countercyclical Buffer is activated.

In order to estimate the likely impact of the increases in capital requirements we need to know in addition the current level of CET1 capital of the Swiss banking sector. In this respect the FINMA consultation paper of October 21, 2011, is useful, as it draws attention to a decisive difference between the two large banks and all other banks in Switzerland. Accordingly, the great majority of the other banks already meet the Basel III capital requirements for CET1 capital. Indeed, the evidence provided in the report shows that the CET1 capital ratios for the other banks are considerably above the Basel III CET1 requirements of 7% and even 9.5%, apart from a few exceptions. Moreover, the CET1 capital shortfall for the other banks amounts to only CHF 1.1 to 1.7 bn in total.[18] Only the two large Swiss banks still require an unspecified amount of additional CET1 capital.[19] In the absence of detailed information we draw on the estimates of the BCBS's Comprehensive Quantitative Impact Study,[20] which include CSG and UBS in the Group 1 banks. Assuming that CSG and UBS meet the average estimates of the BCBS impact study we conjecture that increases in the capital ratio ranging from 100% to 150% are possible.[21]

18 FINMA Erläuterungsbericht (October 21, 2011), pp. 80–82.

19 FINMA Erläuterungsbericht (October 21, 2011), p. 84.

20 BIS (December 16, 2010).

21 According to Table 2 in the Comprehensive Quantitative Impact Study (BIS, December 16) the Net Basel III CET1 capital ratio (after the application of deductions and filters) was 5.7%. Assuming that CSG and UBS met this level, they need to raise CET1 capital by another 4.3% of RWA to reach the targeted minimum of 10% of RWA. But RWAs also increase under Basel III, by about 23% compared to Basel II. Taking this into account the CET1 capital ratio expressed in terms of Basel III RWA drops to 4.6%. This leads us to conclude that a doubling of the CET1 capital ratios from the end of 2009 level is a plausible working assumption, not to mention the Countercyclical Buffer of 2.5% that could be introduced in times of monetary easing.

3. Capital Levels in the Past: Some Stylized Facts

One could think that the sharp increases in common equity requirements would raise the funding costs of banks and trigger a decline in bank lending – and ultimately a slowdown in economic growth. This is a widespread belief, especially in the financial industry.[22] It is based on the observation that equity is more expensive than debt financing and the assumption that the required return on equity is fixed. Indeed, under these conditions higher capital requirements will not only raise the cost of capital for an individual bank, but also the economy wide lending spreads, if banks can pass on the increased costs to their customers. Higher capital costs and higher spreads imply that the banks' credit supply curve shifts inward, and that – if the aggregate demand function remains unchanged – leads to a lower credit volume at higher lending rates. Consequently economic growth will ultimately decline. However, this view is not consistent with a principle of modern corporate finance, i.e. that the very increase in equity reduces the riskiness of a bank's equity and hence the required return on equity. As demonstrated by Modigliani and Miller in 1958, a company's overall cost of funds is unaffected by the mix of equity and debt under perfect capital markets and in the absence of taxes and subsidies. A decrease in equity will simply lead to adjustments in the risk-return relationships of equity and debt. Less leverage implies less financial risk for both debt and equity, and hence leads to reduced required rates of return on equity and debt leaving the overall costs of funds unaffected.[23] It is also well understood that the M-M theorem ignores adjustment costs in moving from one capital endowment to another. Issuing bank equity and debt can be very costly in the short run, especially if it occurs at an inopportune moment. This may lead to temporary increases of overall funding costs, but not to permanent ones.

It is interesting to see that history seems to support the M-M position rather than the banks' claim that higher capital requirements correlate over longer periods with growth difficulties and wider spreads. The figures below show series of the leverage (total balance sheet relative to equity) of the Swiss banking sector, Swiss real GDP growth, and the interest spread between mortgages on the one

22 See IIF (September 2011).

23 A recent paper by Admati, DeMarzo, Hellwig, and Pfleiderer (2010) thoroughly lists and considers the assertions of representatives of the banking industry that higher capital requirements would limit credit supply and economic growth. The authors demonstrate that many of these arguments are "fallacies or irrelevant" or are not supported by "evidence or economic theory".

hand and savings deposits or medium-term bank bonds since 1881 on the other. This initial year is selected as a federal banking act on the issue of banknotes was a first step in banking regulation by the confederation. Before this year banking regulations were the sole responsibility of the cantons and Switzerland was under a regime of free banking. It is striking to note that, from 1881 to 1945, the banks operated with considerably more capital than today. The leverage was well below 10, particularly before World War I. We saw a doubling of the leverage after World War II to 17 during the Bretton Woods period; it subsequently reached a peak of 24 in 2000 and 2007, and was recently at the level of the 1970s.[24] The highly volatile development of the last 20 years is mainly attributable to the leveraging and deleveraging process at the large banks during the period of euphoria, the crisis during the Swiss real estate boom in the 1990s and then the build-up of the subprime bubble after 2004. During the entire period, long-term Swiss economic growth remained close to 2.5% per year and there is no indication that growth was fostered by this increase in the leverage (see Figure 2). On the contrary, if there was any change at all, we would identify a slight decline in average growth over the last 35 years. Thus there is no prima facie evidence that the secular rise in leverage elicited a corresponding upward trend in economic growth, an observation which applies not only to Switzerland but to other countries such as the UK and the USA.[25]

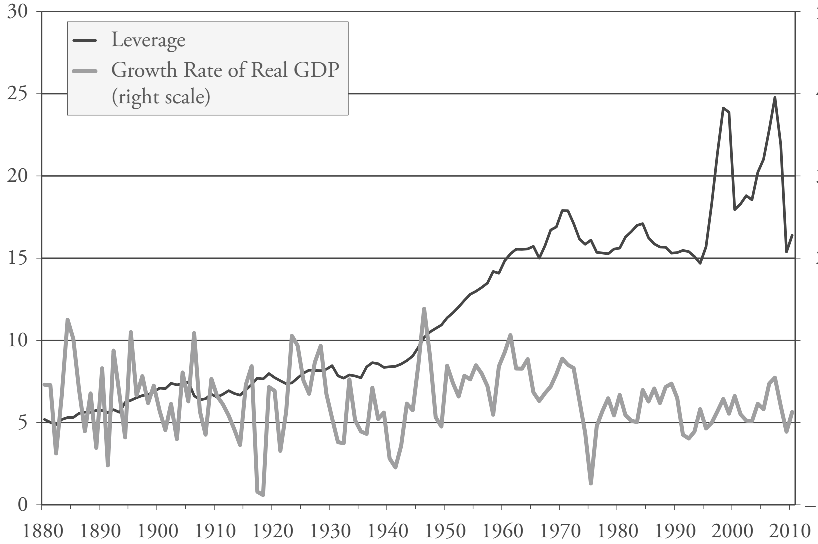
Moreover, as shown in Figure 3, the trend in interest rate spreads between bank lending and bank borrowing does not suggest any improvement for bank customers during the period of strongly increasing leveraging of banks. We show this for three interest rates which are available for our long historical time frame, namely mortgages on the one hand and savings and medium-term bank bonds on the other. The latter spread appears clearly stationary despite the trend increase in leverage. Interestingly, the former spread even widens with the trend increases in leverage, indicating worsening credit conditions or higher costs of financial intermediation by banks during the last 140 years!

Obviously these are very general observations across many different banks. They ignore changes in asset quality and maturity profiles as well as many other potential determinants of economic growth and interest rates besides leverage. Nevertheless, they do not provide any support for claims that higher

24 The increase in leverage between 1945 and 2010 might have been even more spectacular if hidden reserves held in the postwar period were included in the measure of leverage. Of course, there are no reliable statistics on hidden reserves and the extent of this effect is difficult to quantify.

25 See KASHYAP et al. (2010) and MILES et al. (2011).

Figure 2: Leverage and GDP Growth, Switzerland 1881–2010[26]

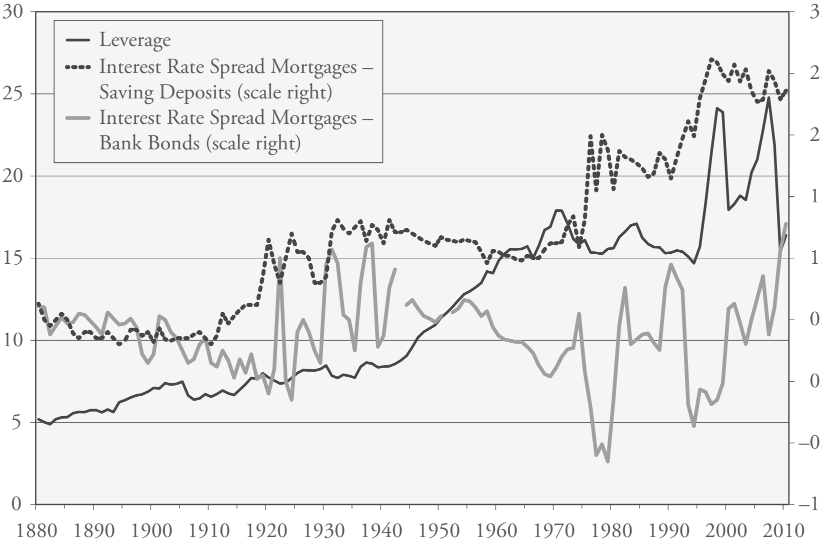


capital requirements imply higher borrowing costs for banks and inhibit economic growth. We can also deduce that these observations are not an isolated phenomenon for any one country, but represent a stylized fact for a number of countries.[27]

26 Data definitions and sources: Leverage: discount banks, land credit banks, cantonal banks before 1906, all banks except private banks and foreign banks from 1906 (Swiss economic and social history online database [http://www.fsw.uzh.ch/hstat/nls/ls_files.php?chapter_var=./o], SNB historical statistics [http://www.snb.ch/de/iabout/stat/statpub/histz/id/statpub_histz_actual], and monthly bulletin [http://www.snb.ch/de/iabout/stat/statpub/statmon/stats/statmon/statmon_D1_1]). GDP: Nominal GDP (OFS, Comptes nationaux 2008, Crise, épargne des ménages et perspectives historiques, OFS, 2011, Rédaction: Christophe Matthey). Real GDP was obtained by deflating nominal values by the CPI (Swiss economic and social history online database, SNB monthly bulletin).

27 See for example USA (Kashyap et al., 2010), UK (Miles et al., 2011) and Sweden (Sveriges Riksbank, 2011).

Figure 3: Leverage and Interest Rate Spreads, Switzerland 1881–2010[28]



4. The Costs of Higher Capital Requirements

4.1 The Econometric Framework

In our econometric analysis we will use the M-M theorem and the Capital Asset Pricing Model (CAPM) as building blocks to derive a relationship between equity beta and leverage. We selected these approaches for a number of reasons. Firstly, both the M-M theorem and the CAPM are well embedded in economic theory. In particular the M-M theorem provides an excellent basis for thinking systematically about the impact of higher capital requirements on the banks' total funding costs. Moreover, the theorem can be empirically tested and the extent to which it holds can be estimated. Sometimes it is asserted that the assumptions of the M-M theorem are far too restrictive and that the theorem does not apply to banks. This objection, however, overlooks the tenet that a good theory

28 Mortgage rates: First mortgages at selected bank before 1937, all banks from 1937 (SNB historical statistics and monthly bulletin). Savings deposit rate: First mortgages at selected banks before 1937, all banks from 1937 (SNB historical statistics and monthly bulletin). Medium-term bank bonds (*Kassenobligationen*) rate: selected banks before 1937, all banks from 1937 (SNB historical statistics and monthly bulletin).

does not depend upon the realism of its assumptions but ultimately on the accuracy of its predictions.[29] It is also worth noting that the relevance of the M-M theorem has been demonstrated recently by a number of empirical studies which used the M-M theorem to estimate the costs of higher capital requirements for banks.[30] Another reason to take the M-M theorem and the CAPM as basis for an empirical analysis is the data requirements. These are relatively modest compared to many macroeconomic models which require a large amount of data in order to specify multiple relationships between the banking sector and overall macroeconomic activity.

The essential point of the M-M theorem[31] is that the expected rate of return on assets is unaffected by the composition of debt and equity. Equation (1) illustrates this:

$$R_{asset} = R_{equity}\frac{E}{D+E} + R_{debt}\frac{D}{D+E} = WACC \quad (1)$$

where R_{asset} is the expected return banks earn on their assets, R_{equity} is the expected return on equity, R_{debt} is the expected return on debt. The risky assets A of the banks are financed by equity (E) and debt (D) and equation (1) is the weighted sum of the cost of bank equity and the cost of bank debt, which is also known as the weighted average cost of capital ($WACC$).

Although the weighted average of equity and debt, R_{asset}, is unaffected by changes in the composition of equity and debt, the returns on the individual securities are not. They respond to changes in leverage. If the bank raises equity and reduces debt, the expected returns on equity, R_{equity} and on debt, R_{debt} will fall. Investors are indifferent to the reductions in R_{equity} and R_{debt} because the decreased returns are exactly offset by corresponding reductions in the risk of bank equity and bank debt. Thus, just as with R_{asset}, the risk on the bank's assets, β_{asset}, is the weighted average of the risk of equity and debt:

$$\beta_{asset} = \beta_{equity}\frac{E}{D+E} + \beta_{debt}\frac{D}{D+E} \quad (2)$$

where β_{equity} is the risk on bank equity and β_{debt} the risk of bank debt.

29 For more details, see Friedman (1953, pp. 39–43).
30 See in particular, Kashyap et al. (2010), Miles et al. (2011), Elliot et al. (2012) and Elliot (2009).
31 For a review of the M-M principles, see Brealey, Myers, and Allen (2008), Chapter 18.

Together, equations (1) and (2) state that reductions in financial leverage do not affect the risk and expected return on the bank's assets, but they do reduce the risk and return on equity and debt individually.

Assuming that debt is roughly riskless, β_{debt} is equal to zero and equation (2) becomes

$$\beta_{equity} = \beta_{asset} \frac{E + D}{E} \tag{3}$$

Equation (3) establishes a linear relationship between equity risk, β_{equity}, and leverage: $(\mathrm{E} + \mathrm{D}) / E$. A reduction in leverage (i.e. an increase in equity) lowers the equity risk proportionally. For example, assume a bank that initially has a leverage of 40 and an equity market beta of 2. Now capital requirements are raised so that leverage is halved to 20. This will lead to a corresponding decline of the equity beta from 2 to 1. The same risk is now spread over an equity buffer that is twice as large. Therefore, each unit of equity only bears half as much risk as before; hence, equity beta falls by half.

Equation (3) is based on the assumption that debt is riskless. For the purpose of our analysis this assumption is less restrictive than it seems at first sight. First, note that large parts of banks' deposit liabilities are close to riskless because of explicit or implicit deposit insurance. Second, in making this assumption we do not deny that in reality non-deposit liabilities are inherently risky. Rather we focus on the core message of the M-M relationship, which is that more leverage makes equity more risky and vice versa. In ignoring an impact on the return on debt the decrease of leverage leads to an increase of *WACC,* which is larger than it would be in case of risky debt. Thus, the assumption of riskless debt is conservative as it ensures that the social costs of higher capital requirements (lower leverage) are not understated. Finally, it is also worthwhile noting that textbooks of corporate finance typically assume that the debt of a company is riskless at low debt levels and becomes risky only at higher levels of debt.[32] In contrast, the equity risk and the required rate of return on equity increase continuously with leverage. All in all we believe that the linearization of the M-M relationship is reasonable and does not invalidate the essence of the M-M relationship.[33]

32 See for example BREALEY, MYERS and ALLEN (2008, chapter 18.3).

33 Similar arguments are provided by MILES et al. (2011). In addition the authors argue that the assumption of riskless debt in Equation (3) does not mean that the default probability of debt is zero but refers to the CAPM and "the weaker condition that any fluctuation in in the value of debt is not correlated with general market movements" (see MILES et al., 2011, footnote 6).

Equation (3) can be empirically tested. All this requires is to use of the second building block of our econometric approach, the CAPM and estimate equity betas. The Capital Asset Pricing Model states that a company's expected excess return on equity is proportional to its beta times the expected excess return on the market portfolio,

$$R_{equity} = R_f + \beta_{equity}(RoM - R_f) \tag{4}$$

where R_f is the risk-free rate of interest and *RoM* the expected return on the market portfolio.

There are various ways to derive the above linear relationship (equation 3) between equity beta and leverage. One alternative possibility is to start with the recognition that CAPM holds for any asset. Thus the expected return on the assets of a company, R_{asset}, can be expressed as:

$$R_{asset} = R_f + \beta_{asset}(RoM - R_f) \tag{5}$$

Plugging equations (4) and (5) into equation (1) yields equation (3) again, which is the starting point for our econometric analysis.

4.2 Beta Estimates and Comparisons Across Banks

We estimate semi-annual and quarterly betas for the banks in our sample, assuming that risk-free rates are constant over any of the three or six month periods. Therefore our beta estimates for a given bank are obtained by regressing each quarter or each half-year of the bank's daily stock returns on the daily return of the market index, i.e. we run the following regression

$$\Delta p_{i,t,n} = \alpha_{i,t} + \beta_{i,t}\Delta i_{t,n} + \nu_{i,t,n}$$

where $\Delta p_{i,t,n}$: daily log stock return of bank i

$\Delta i_{t,n}$: daily log market return of SMI

$\nu_{i,t,n}$: daily error term

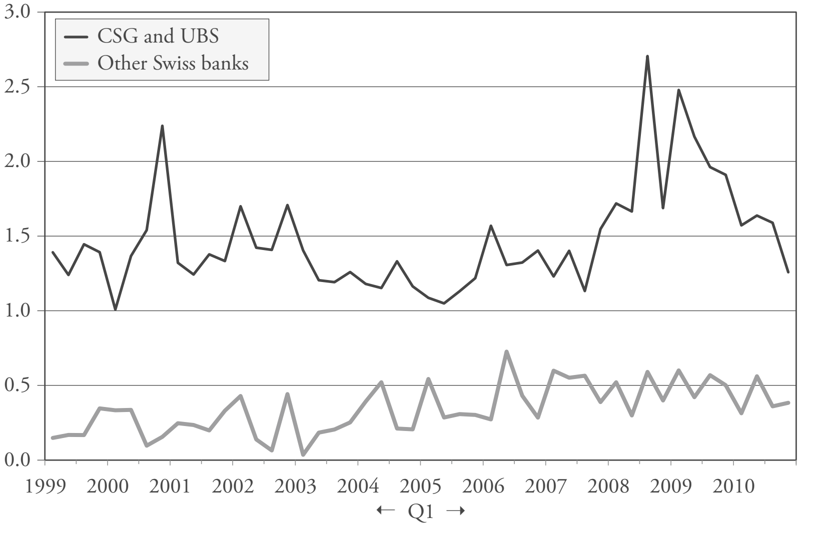
for each quarter or half-year ($t = 1, \ldots, T$) in our sample. Daily closing prices for the sample banks and the Swiss Market Index (SMI) are obtained from Datastream[34]. In order avoid zero returns due to Swiss business holidays we exclude

34 Datastream: Thomson Reuters.

those days from the sample at which prices of all banks and the value of the SMI did not deviate from their values at the previous business day's close.

Figure 4 shows the average of the equity betas for Credit Suisse and UBS and for three other banks where price quotations were available on a daily basis and trading volumes seemed sufficiently large to estimate betas.[35] Not surprisingly, the betas of the two large Swiss banks are significantly above the betas of the three other banks. The average beta for the two large Swiss banks was 1.5 and for the other three banks 0.5 between 1999 and 2010. The two humps in the time series for the two large banks are clearly related to shifts in investor sentiment during the telecom crisis around 2000 and the subprime crisis in 2008/09. The average betas of the other three banks follow a slight upward trend and exhibit far less volatility.

Figure 4: Average β for Large and Selected other Swiss Banks



35 The three banks are Banque Cantonale Vaudoise, Bank Sarasin and Valiant Bank. There are a number of other banks that are publically traded on the Swiss Stock Exchange, but for various reasons they did not qualify for the estimation of CAPM-βs (availability of time series back to 1999, sticky price quotation, missing values, etc.).

4.3 *Regression of β on Leverage (M-M Theorem)*

The β estimates of individual banks (in the equation above) are regressed on the banks' leverages. The leverage (*lr*) is defined as a bank's total balance sheet over its Tier 1 capital. We use a logarithmic specification as it allows a direct and easy test of the M-M hypothesis, namely that the slope coefficient of this regression is equal to 1. Note that we include a lagged leverage in order to avoid simultaneity problems. Moreover, we use panel data econometric methods taking into account bank specific effects and time specific effects:

$$\log(\beta_{i,t}) = a + b\log(lr_{i,t-1}) + \eta_i + \delta_t + \varepsilon_{i,t}$$

where $\beta_{i,t}$: estimated β of bank i in quarter or half-year t
$lr_{i,t}$: leverage of bank i in quarter or half-year t
η_i : bank-specific effect
δ_i : time-specific effect
$\varepsilon_{i,t}$: error term

Bank effects capture all the unobservable time invariant characteristics of the bank and time effects account for all the macroeconomic variables affecting all banks in the same way. The fixed effects (FE) specification introduces dummy variables for banks and time periods and allows a direct OLS regression estimate of the two effects. This model is optimal if effects are correlated with leverage (the observed regressor), otherwise it is only consistent. In this framework we can test for the significance of the effects by standard F-tests. The random effect (RE) specification treats the effects as independently distributed stochastic unobservables corrected for by a Feasible Generalized Least Squares method. This model is optimal (efficient) if the observable regressor is uncorrelated with these effects. These specifications can be mixed, e g. fixed bank and random time effects. The RE specification can be tested against the FE specification with a Hausman test.

We consider two panels: Firstly we pool the bi-annual data for all banks with systematic variation in the β estimates (CSG, UBS, Banque Cantonale Vaudoise, Bank Sarasin, Valiant Bank)[36]. This model was estimated in two specifications: the first assumes a common slope coefficient across all banks and the second allows for a different slope-coefficient for large banks (CSG, UBS) and small banks. Secondly we estimated the model only with CSG and UBS data using

36 For the other banks the β estimates vary randomly around zero and show no systematic variation.

bi-annual and in addition quarterly data, which is available for these two banks.[37] The corresponding results are reported in Table 1. We always started from a two-way fixed effects model and then tested the statistical significance of the effects and specified the model correspondingly. Then we considered random effect specifications by applying Hausman tests. Table 1 reports the estimate obtained by the "optimal" specification according to all these tests.

Table 1: Estimated Elasticity of β with Respect to Leverage, Swiss Banks, 1999–2010

	All banks	All banks Different slope coefficient *b* for large and other banks	CSG, UBS	CSG, UBS
Frequency Time period	Biannual 1999–2010	Biannual 1999–2010	Biannual 1999–2010	Quarterly 2001–2010
Bank effect F-statistics	Random 24.73***	Random 17.44***	Fixed 12.97***	Fixed 16.62***
Time effect F-statistic	None 1.60	None 1.60	Fixed 4.97***	Fixed 5.35***
b (all)	0.763** (0.289)			
b (large banks)		0.790** (0.289)	0.554** (0.173)	0.545*** 0.119)
b (other banks)		0.533 (0.351)		
a (constant)	–3.170*** (0.975)	–2.833*** (1.013)	–1.722*** (0.651)	–1.723*** (0.455)
t-statistic H_0: b = 1	–0.82	–0.73 –1.33	–2.58***	–3.83***
R-squared	0.307	0.477	0.844	0.849
Hausman test	2.416	3.725	5.966**	10.091***

Notes: *,**,*** indicates significance at the 5%, 1% and 0.1% level, respectively (null hypothesis for t-statistics: b=0, a=0).
Standard errors are given in parentheses.

37 Data is collected from different sources. For the large banks, balance sheet data and BIS Tier 1 capital were collected from Datastream and the banks' Quarterly Reports at group level. For the other banks FINMA provided data for total assets (balance sheet) and Tier 1 capital at parent bank level.

Our estimates indicate a statistically significant and robust relation between the CAPM-β and leverage. The estimated elasticity is in the 0.53 to 0.79 range. For the panel of all banks we cannot reject the hypothesis that $b = 1$ whereas for the large bank panel this hypothesis is clearly rejected indicating that we have a partial M-M effect. The average constant estimates is always negative implying according to equation (3) that β_{asset} is smaller 1 on average. Note that this intercept varies over banks and time according to bank and time effects included in the estimation. For the panels including all the banks we cannot reject the hypothesis that this coefficient is equal the M-M value of 1. Therefore M-M effects are clearly present in our dataset and an increasing leverage is clearly associated with higher equity returns. Correspondingly, deleveraging would decrease the costs of equity. Moreover, it is interesting to note that our results are similar to those of Miles et al (2011) for UK banks. These authors report elasticities between 0.6 and 0.69.

4.4 Calibration of Magnitudes to the Swiss Financial Sector

Following Kashyap et al (2010) and Miles et al (2011), we use the estimated relationship between bank leverage and the equity beta to assess how changing leverage affects the average cost of capital, *WACC,* of large banks. For this we first plug the estimated coefficients from the regressions into the of CAPM equation (4) to calculate R_{equity}. This yields:

$$R_{equity} = R_f + (\widehat{a} + \widehat{b} Leverage) R_p \tag{6}$$

where $\widehat{a}$ is the estimated constant, $\widehat{b}$ is the estimated coefficient on leverage from the beta regressions and R_p is the equity market risk premium $(RoM - R_f)$.

Second we adapt equation (1), i.e. *WACC*, to the assumptions and data that we used in the regression analysis, namely that debt is essentially risk-free and approximated by the risk-free rate R_f. We regard this assumption as conservative because it does not understate the increase in *WACC* resulting from an increase in capital requirements as already explained above. Thus replacing R_{debt} by R_f yields a modified version of equation (1):

$$WACC = R_{equity} \frac{E}{D+E} + R_f \left(1 - \frac{E}{D+E}\right). \tag{7}$$

Equations (6) and (7) provide the ingredients to further investigate the implications of the regression results for the large banks and the Swiss economy. To do so, note that total assets of the two large Swiss banks averaged about CHF 3182 bn between 2006 and 2010. Tier 1 capital was CHF 70 bn and RWAs were about CHF 550 bn. The average leverage of the two banks measured as total assets to Tier 1 capital was 45.5. The risk-free money market rate, i.e. the repo reference of the SNB, was about 1% over that period. As equity market risk premium, we use two estimates, an upper observed historical value of 12.35% for the period 1982 to 1998[38] and a lower estimate of 4.66% calculated on the Swiss Performance Index (SPI) for the period 1990 to 2010.[39] We will apply both observations first in order to take account of the well-known fact that equity risk premiums vary greatly in size over time and second in order to provide reasonable upper and lower estimates. As we will see later, the final results are less dependent upon the risk premium than it may appear at a first glance.

Inserting the estimates $\widehat{a}$ and $\widehat{b}$ of the quarterly CSG/UBS regression into equations (6) and (7) yields a

return on equity: $1\% + \exp(-1.72 + 0.55 \ln(45.5)) 12.35\% = 18.64\%$

respectively: $1\% + \exp(-1.72 + 0.55 \ln(45.5)) 4.66\% = 7.65\%$

and for *WACC*: $18.64\% \frac{70}{3182} + 1\% \left(1 - \frac{70}{3182}\right) = 1.39\%$

respectively: $7.65\% \frac{70}{3182} + 1\% \left(1 - \frac{70}{3182}\right) = 1.15\%.$

The returns on equity of 18.64% respectively 7.65% represent orders of magnitude and not exact estimates. The upper estimate of 18.64% is consistent with the average realized returns on equity of the large banks during the boom period prior to the subprime crisis. It is also close to the targeted returns on equity announced by the banks before the crisis.[40] The lower estimate of 7.65% is representative for the average realized returns on equity covering both boom and bust periods.

38 CAMPBELL (2002): For details see Tables 5 and 6.

39 We used the annual return of the SPI and the and the 12 month CHF libor rate as the risk-free money market rate. The annual risk premium of 4.66% is the arithmetic average of annual risk premiums calculated as annual return of the SPI return minus 12 month CHF libor rate for the period 1990 to 2010. For the SPI see SIX Swiss Exchange and SNB for the 12 month CH libor rate.

40 See annual reports of CS and UBS with returns on equity above 25% in the years before the crisis. More recently the banks have adjusted their targeted returns on equity to some

If leverage is reduced by half from 46 to 23 our empirical results suggest a material fall in the required return on equity and an increase in *WACC*. At a given risk premium of 12.35%, the required rate of return declines from 18.64% to 13.09% and *WACC* increases from 1.39% to 1.53% or an increase of 14.4 bps. At the lower risk premium of 4.66% the absolute changes are smaller, i.e. the required rate of return drops from 7.65% to 5.56% and *WACC* increases by 5.4 bsp. However, the relative magnitudes are similar. Table 2 below summarizes the results based on the estimated elasticity of $\widehat{b}$ = 0.55 for the M-M effect together with two other scenarios, first assuming that the M-M theorem holds perfectly and second, that the M-M theorem would not hold at all.

The estimated elasticity of $\widehat{b}$ = 0.55 implies that the M-M effect is about 55% of what it would be if the M-M theorem were to hold exactly. Note also (Table 1 above) that the panel regression including all banks yields an even higher coefficient of 0.79 for the large banks, suggesting that the empirical M-M effect could be even larger. At the extreme, if we assume that the M-M theorem holds perfectly, a reduction in leverage by half would reduce the return on equity to about 9.82%, respectively 4.33% while the *WACC* would remain unchanged. On the other hand, if the M-M theorem does not hold at all, the burden of a reduction of leverage by half would fall entirely on *WACC*, which would rise by 38.7 bps respectively 14.6 bps, while the return on equity would be fixed. The results are summarized in Table 2.

Table 3 shows the impact on *WACC* for a range of reductions in leverage (33%, 50% and 60%) and the concomitant increases in CET1 capital ratios (50%, 100% and 150%).[41] The results on the left side of the table are based on the quarterly regression for the two large banks as reported in Table 1. The results on the right side of the table assume that the required return on equity is fixed, i.e. the M-M effect is ignored.

15% to 20%. For more details, see CS: Presentation at Morgan Stanley European Financials Conference, March 30, 2011 https://www.credit-suisse.com/investors/de/presentations.jsp? sortColumn=location&sortDirection=asc and UBS: UBS Investor Day, November 17, 2011: http://www.ubs.com/global/de/about_ubs/investor_relations/_jcr_content/par/linklist_1/link.174255166.file/bGluay9wYXRoPS9jb250ZW50L2RhbS91YnMvZ2xvYmFsL2Fib3V0X3Vicy9pbnZlc3Rvcl9yZWxhdGlvbnMvaW52ZXN0b3JkYXkvMjAxMS9VQlNfMjAMV9JbnZlc3Rvci1EYXlfQ0VPLnBkZg==/UBS_2011_Investor-Day_CEO.pdf.

41 Changes in CET1 capital ratios and corresponding changes in leverage are derived from the BIS Quantitative Impact Study, see footnote 21 above.

Table 2: Estimated and Simulated Impacts on Return on Equity and *WACC*

Scenarios	Variables	Risk Premium 12.35% Leverage: 46	Leverage: 23	Change in bps	Risk Premium 4.66% Leverage: 46	Leverage: 23	Change in bps
Regression equation: Large Banks	Return on equity	18.64%	13.09%	–554.5	7.65%	5.56%	–209.2
	WACC	1.39%	1.53%	14.4	1.15%	1.20%	5.4
Implied, if M-M holds perfectly	Return on equity	18.64%	9.82%	–881.7	7.65%	4.33%	–332.7
	WACC	1.39%	1.39%	0.0	1.15%	1.15%	0.0
Implied, if M-M does not hold at all	Return on equity	18.64%	18.64%	0.0	7.65%	7.65%	0.0
	WACC	1.39%	1.78%	38.7	1.15%	1.29%	14.6

Table 3: Large Banks: Impact on *WACC* Resulting from Reductions in Leverage and Concomitant Increases in CET1 Capital Ratios

Change in leverage	Increase in CET1 capital ratio	Based on regressions: Impact on *WACC* (Eq. Pr. = 4.66%)	Impact on *WACC* (Eq. Pr. = 12.35%)	No M–M effect: Impact on *WACC* (Eq. Pr. = 4.66%)	Impact on *WACC* (Eq. Pr. = 12.35%)
–33%	50%	3.0	7.9	7.3	19.4
–50%	100%	5.4	14.4	14.6	38.7
–60%	150%	7.6	20.1	21.9	58.1

Perusal of the results in Table 3 elicits three stylized facts:

1. Most interestingly, even relatively large increases in the capital ratio in the range of 100% to 150% would raise *WACC* by only 14 to 20 bps (assuming an equity premium of 12.35%) and by 5 to 8 bps (assuming an equity premium of 4.66%). These are modest increases by any standards if benchmarked against the historical widening of credit spreads and against the increases in *WACC* without the M-M effect (see the right side of Table 3).
2. Not surprisingly, the relationship between changes in risk premiums and *WACC*-increases are linear. Reducing the risk premium by half (or 62% given the selected market risk premiums) leads to a reduction in the *WACC*-increase by half (62%).

3. No matter what size the equity risk premium takes, the M-M effect is valid under any prevailing equity risk premium. Although the absolute prediction of *WACC*-increases depends on the equity risk premium, the relative prediction does not. For example, given an increase of the capital ratio by 100%, the *WACC* increase with the M-M effect is always 37% of the *WACC* increase without an M-M effect independent of the assumed equity risk premiums.

In order to estimate the economy-wide increase in lending spreads a number of considerations must be taken into account. First, it is important to keep in mind that only the two large Swiss banks are under the pressure to raise capital levels. Second, given the strong competition among banks in Switzerland, the large banks will face constraints on raising their lending spreads. Combined with the comfortable capital situation for other banks, it is very unlikely that the large banks will be able to raise their lending spreads on a one-for-one basis with higher *WACC*. Rather, the large banks will be faced with a choice between either raising the lending spreads for their customers and losing business or forgoing the increase in lending spreads and retaining their market share. This implies that the economy-wide lending spreads will most likely remain unchanged.

Third, even if the large banks are able to pass on higher *WACCs* one-for-one to their customers, economy-wide lending spreads will increase only by a certain proportion, determined by the share of large banks in domestic lending and the share of bank lending in Swiss companies' external financing.

The share of the two large Swiss banks in domestic lending is about one third, and the share of bank lending in the external financing of Swiss companies is also one third. Thus, lending spreads, and hence households' cost of capital could, if at all, rise at a maximum by 33% of the *WACC*-increase. Thus, given the doubling of the CET1 capital ratio (reduction of leverage by half) and the corresponding *WACC*-increase at large banks by 5.4 respectively 14.4 bps, the households' cost of capital will increase by only 1.8 respectively 4.7 basis points. The impact on the capital costs of the nonfinancial corporate sector will be even smaller, namely about 11% (0.33×0.33) of the *WACC*-increase. As shown in Table 4 none of the scenarios show material increases in cost of capital for households and companies of the nonfinancial sector. Even under the assumption of no M-M effect the impact on households and nonfinancial companies remains negligible. There is only one very unlikely scenario, which could trigger important changes in lending spreads: If the large Swiss banks were able to impose their *WACC* increases on the other Swiss banks and if the M-M effect is ignored, lending spreads could increase at the most by 14.6 and 38.7 bps, respectively.

Table 4: Increase in CET1 Capital Ratio and Impacts on *WACC* of Large Banks, Households and Capital Costs of the Nonfinancial Sector

Increase of CET1 ratio by 100%	Based on regressions		No M-M effect	
	Eq. Pr. = 4.66%	Eq. Pr. = 12.35%	Eq. Pr. = 4.66%	Eq. Pr. = 12.35%
Impact on large banks *WACC* (bps)	5.4	14.4	14.6	38.7
Impact on households (bps)	1.8	4.7	4.8	12.8
Impact on the capital costs of the nonfinancial corporate sector (bps)	0.6	1.6	1.6	4.2

It is interesting to note that the IIF estimates an increase of lending spreads of 40 bps for Switzerland for the period 2011 to 2020[42], i.e. an impact on nonfinancial companies' cost of capital that is 26 to 69 times higher depending on the assumed risk premium. As in our case, the IIF assumes a doubling of the CET1 capital ratio. However, unlike us, the IIF does not empirically estimate the parameters but uses expert opinions to determine them. Without providing empirical estimates the IIF assumes that the M-M effect does not play a role (at least not in the medium run up to 2020) and furthermore presumes that compensation policies and operational efficiency remain unchanged.[43] Given these conditions and the very unlikely scenario in which the large Swiss banks are able to impose their terms on the rest of the Swiss banking sector, the differences between the results can be reconciled. Removing the M-M effect (i.e. assuming a constant R_{equity}) and assuming the high risk premium of 12.35%, our estimation yields an increase in economy-wide lending spreads of 39 bps.

42 See IIF (September 2011): Table 5.2 Tightening in Credit Conditions (page 54).

43 There is a remarkable incoherence between the claims of certain bankers that the Modigliani-Miller analysis does not apply for banks and the use of bank-internal models that are based on the same principles bankers deny to apply to their banks. This is well pointed out by ADMATI et al. (2010), page 18: "The assumptions underlying the Modigliani-Miller analysis are in fact the very same assumptions underlying the quantitative models that banks use to manage their risks, in particular, the risks in their trading books. Anyone who questions the empirical validity and relevance of an analysis that is based on these assumptions is implicitly questioning the reliability of these quantitative models and their adequacy for the uses to which they are put – including that of determining required capital under the model-based approach for market risks. If we cannot count on markets to correctly price risk and adjust for even the most basic consequences of changes in leverage, then the discussion of capital regulation should be far more encompassing than the current debate."

4.5 Estimating the GDP Costs of Higher Capital Requirements

To estimate the economic costs of higher capital requirements we need to estimate the impact of higher lending spreads on production measured by GDP. Instead of using a disaggregated macro-econometric model which necessarily involves a lot of debatable specifications affecting the result in a potentially not particularly transparent way, we follow the simple approach adopted by Miles, Yang, and Marcheggiano (2011, pp. 21–22), which is based on a CES-production function for GDP with capital and labor inputs and technological progress, $Y=f(K,L,t)$. If factor prices are equal to marginal products, elasticity of production with respect to the price of capital can be written simply as a function of the substitution elasticity σ and the elasticity of production with respect to capital α (equal to the income share of capital):

$$\frac{dY}{dP_K}\frac{P_K}{Y} = -\sigma\frac{\alpha}{1-\alpha} \qquad (8)$$

Equation (8) is based on growth theory and therefore provides an estimate of the long-run impact of an increased price of capital on production. In line with neoclassical growth theory a permanent increase in the price of capital leads to permanent change in the level of production but has no long-term effect on its growth rate, which is determined by labor supply growth and technical progress.

The estimation of a CES-production function with annual data from 1991 to 2010, reported in detail in an appendix, results in a σ-estimate of 0.992 which does not differ statistically and economically from 1. Therefore our CES function is essentially a Cobb-Douglas production function and the corresponding α-estimate is 0.304. Given this estimate, equation (8) implies that a permanent increase in capital costs of 1% would lead to a permanent reduction in the level of GDP of 0.43%. Of course this production loss will occur every year, and therefore the discounted production loss will be much larger. For instance, if we assume a discount rate of r = 5% then the production loss is 20 times larger (1/r) than the permanent annual reduction of GDP, namely 8.6% in our case.

The capital costs for the Swiss companies were determined in line with the assumed market risk premiums of 4.66% and 12.35%. To this end we first estimated the equity beta of the Swiss companies, i.e. we ran a similar regression as in section 4.2 for the period 1990 to 2010, however this time with returns on the index of the Swiss corporate sector (excluding financial and insurance companies) as left-hand variable and the returns of the SMI as right-hand variable in addition to the constant alpha: $\Delta CorpIndex = \alpha + \beta * \Delta SMI + \varepsilon$.

Not surprisingly the beta for Swiss companies turned out to be close to 1. Based on the daily closing prices we estimated a corporate sector beta of 1.021. Next, we used equation 4 of the CAPM and calculated the capital costs for the Swiss companies under the same assumptions as we calculated the return of equity for the banks (see section 4.4):

Upper estimate capital costs for Swiss companies:
$1\% + 1.012 \times 12.35\% = 13.61\%$
Lower estimate of capital costs for Swiss companies:
$1\% + 1.012 \times 4.66\% = 5.75\%$

Adding the increases in cost of capital (see Table 4) to above upper and lower estimates of capital costs and inserting the result into equation (8) yields the GDP costs. For example, the increase in lending spreads of 1.54 bps (assuming the market risk premium of 12.35%), amounts to a 0.11% increase in the cost of capital for companies ($1.57 / 1361 = 0.12\%$). Given the estimates of the CES production function this translates into a permanent fall in GDP of 0.050%, that is 0.11 $[\sigma(\alpha / (1-\alpha))]$. Table 5 summarizes the results for all other combinations. The overall conclusion is that the social costs of significantly higher capital ratios measured in terms of permanent changes in GDP are negligibly small no matter what market risk premium is applied. An increase in the CET1 capital ratio of 100% would lead to a permanent fall of GDP of only 0.044% to 0.050% or about 1% (0.89 – 1.00%) using an annual rate of 5%. This does not include the adjustment costs to higher capital ratios. However, these costs are only transitory and, given the fact that the regulatory changes are implemented within a transition period running to 2018, they are plausibly not very high and will not change the overall results.

The corresponding IIF estimate is an annual decline of 0.3% which reduces the level of real GDP by 2.9% in 2020.[44] This result is driven by above mentioned decision of the IIF to ignore the Modigliani-Miller analysis and other highly questionable assumptions.[45] In contrast, our estimate suggests that the GDP reduction is about 60 times smaller.

44 See IIF (September 2011): Table 5.3 Change in Real GDP and Employment (page 56).
45 In the Swiss part of the model real GDP is essentially driven by bank credits and all other determinants of GDP are not taken into account. Moreover, most of the model parameters are imputed and not estimated in a proper way.

Table 5: Social Costs Measured in Terms of Capital Costs of the Nonfinancial Sector and GDP Costs

Large Banks: Social Costs of increased Capital Ratios			
Change in CET1 capital ratio	Change in leverage	Impact of the capital costs of the nonfinancial corporate sector (in bps)	GDP impact
50%	–33%	0.32 to 0.86	–0.024 to –0.027%
100%	–50%	0.59 to 1.57	–0.044 to –0.050%
150%	–60%	0.82 to 2.19	–0.062 to –0.070%

Note: The first number in columns 3 and 4 refers to the market equity risk premium of 4.66% and the second to the market equity risk premium of 12.35%.

5. The Benefits of Higher Capital Requirements

Higher capital requirements not only raise costs, they also convey significant social benefits. Better capitalized banks are less crisis-prone, and moreover they reduce the systemic risk in the financial sector. History has repeatedly shown that social cost of banking crises in terms of forgone economic growth and output fluctuations are material. Typically, recessions caused or accompanied by banking crises are deep and long-lasting. In this section we will estimate the benefits of higher capital requirements by first estimating the permanent effect of banking crises on GDP and next the dependence of the annual probability of banking crises on leverage. We consider only permanent decreases in GDP associated with banking crises. Short and medium term dynamics during the crisis are ignored. This is in line with our cost estimates discussed in the previous section taking only into account long run effects of higher capital requirement.

5.1 Estimation of the Severity of Banking Crises

To estimate the impact of banking crises on economic output we use annual Swiss GDP data starting from 1881 and identify the major severe and long-lasting recessions since then. Switzerland experienced four fully fledged banking crises since 1881, namely in 1911, 1931, 1991 and 2007.[46] In 1911 and 1991 the

46 Ritzman (1973) is a comprehensive reference for the history of Swiss banks. SNB (2007) provides some information on the history of banking crises in Switzerland including the crisis of 1991.

insolvent banks could be taken over or restructured without government support. However, government support was needed to bail out the "Schweizerische Volksbank" and the "Banque d'Escompte Suisse" in 1931 as well as UBS in 2007. In addition, we account for the two world wars (1917 and 1942) as well as the oil price shock of 1974.

In order to estimate the long run impact of these crises we use a deterministic time trend model for log GDP taking into account the effects of major shocks by including level shift dummy-variables (being equal to 0 before the event and 1 after) for all major adverse shocks:

$$\begin{aligned}\log(GDP) = \gamma_0 + \gamma_1 t + \delta_1 D1911_t + \delta_2 D1931_t + \delta_3 D1991_t \\ + \delta_4 D2007_t + \delta_5 D1917_t + \delta_{16} D1942_t + \delta_7 D1974_t + \varepsilon_t.\end{aligned} \tag{9}$$

The dummies do not capture the short-run effect of a crisis but only its permanent effects on GDP. Thus the results are robust and minor differences of plus or minus one year in dating the crises do not matter. The transitory cyclical deviations from trend are captured by the residual of equation (9) which we expect to be strongly autocorrelated but stationary. Therefore we only try to account for permanent changes in the level path of GDP and do not attempt to model transitory changes of GDP explicitly. In this framework the crucial hypothesis is that the residual of this deterministic trend equation is stationary. This means that all other shocks as the change in the monetary regime (gold standard, Bretton Woods and flexible exchange rates) as well as other crises in foreign exchange or financial markets (for instance the 1978 DM shock, the bursting of the IT bubble in 2001/2) had only temporary effect on the level of GDP.

Before turning to the results of this model we have to stress that the residuals of this deterministic trend break model displayed in Figure 5 appear to be stationary. Indeed, the residuals are identified as following an AR(1) process with a coefficient of 0.84 and a Kwiatkowski-Philips-Schmidt-Shin test does not reject at any reasonable significance level the null hypothesis of stationarity (KPSS = 0.0797, 10% critical value = 0.119). However, the standard critical values are not valid for residuals of trend break models. In order to get the appropriate critical values we ran 1000 bootstrap replications taking into account the AR(1) property of the residuals. By this exercise we obtained 10%, 5% and 1% critical values of 0.145, 0.169 and 0.212, respectively. Thus, the stationarity hypothesis is clearly in line with the data, as the KPSS statistic calculated is clearly lower than the appropriate 10% critical value of 0.145.

The empirical results for this model and annual Swiss data from 1881–2010 are presented in Table 6. First of all, consider the coefficient estimate for the time trend γ_1: It is 0.039, which implies a potential GDP growth of nearly 4% instead of the historical average of 2.7%. This reduction of measured GDP growth was brought about by permanent shifts of the GDP growth path by the crises reflected in our dummy variables. Therefore, in the hypothetical case of no future major adverse shocks Swiss GDP growth would converge to 3.9% according our point estimate. Moreover, we see that, in particular, the occurrence of banking crises has a strong and highly statistically significant permanent negative impact on the level of GDP. For instance, we see that the largest negative impact of approximately 40% is associated with the crisis in the early 1990's (estimate of δ_3 is –0.406). The latter estimated effect may appear surprisingly large given the fact that only some small bank failed in this crisis. However, the crisis led to large write offs amounting to approximately 8.5% of outstanding loans and to a complete restructuring of the Swiss banking sector. Many regional and cantonnal banks and two large banks (Volksbank, Bank Leu) were taken over by the three remaining large banks. The merger or SBC and UBS in 1998 reduced the number of large banks to two[47]. For the other adverse shocks we also found negative permanent effects, but their impact is lower and of lesser statistical significance. In fact, the F-tests reported indicate that the effects of all banking and non-banking crises are different: the F-statistic of 2.799 is larger than the 5% critical value of 2.17. The effects of the banking and the non-banking crises/events are moreover not statistically significantly different: the F-statistics of 1.784 and 1.658 are lower than the corresponding 10% critical values of 2.13 and 2.35, respectively. Therefore we estimated a restricted model assuming the same effects for all four banking crises and the three non-banking crises, respectively. This allows us to get the estimated average impact of a banking and a non-banking crisis.

The results of the restricted model are reported in the last column of Table 6. The estimates indicate that a severe banking crises leads to a permanent and highly statistically significant decrease in real GDP of approximately 28%, whereas the other adverse shocks lead "only" to an approximately 10% permanent reduction of GDP which is only marginally significant at the 10% level. The difference between these two estimates represents the additional negative GDP effect of a crisis with severe banking problems. This is approximately -18% with a standard error around 6%. The value is therefore statistically significant

47 Schweizerische Nationalbank (2007, Chapter 7.3).

at the 1% level.[48] This estimate will be used in our calculations of the benefits of avoiding banking crises presented below.

Table 6: Estimated Trend Model with Crises Dummies, Real GDP, 1881–2010

Regressor	Coefficient estimates, unrestricted		Coefficient estimates, restricted	
Intercept	5.073	(0.237)***	5.108	(0.206)***
T	0.039	(0.0034)***	0.038	(0.0034)***
D1911	–0.228	(0.079)***	–0.285	(0.051)***
D1931	–0.194	(0.079)***	–0.285	(0.051)***
D1991	–0.406	(0.104)***	–0.285	(0.051)***
D2007	–0.198	(0.079)***	–0.285	(0.051)***
D1917	–0.236	(0.050)***	–0.109	(0.063)*
D1942	–0.123	(0.095)	–0.109	(0.063)*
D1974	–0.098	(0.103)	–0.109	(0.063)*
Adjusted R^2	0.990		0.988	
Standard error of residual	0.109		0.115	
Durbin-Watson statistics	0.310		0.276	
F-test: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7$	2.799**			
F-test: $\delta_1 = \delta_2 = \delta_3 = \delta_4$	1.784			
F-test: $\delta_5 = \delta_6 = \delta_7$	1.658			
Difference between banking and non-banking crises: $\delta_1 - \delta_5$			–0.177	(0.0613)***

Notes: *,**,*** indicates significance at the 5%, 1% and 0.1% level, respectively.
Standard errors corrected for heteroscedasticity and autocorrelation (Newey-West) are given in parentheses.

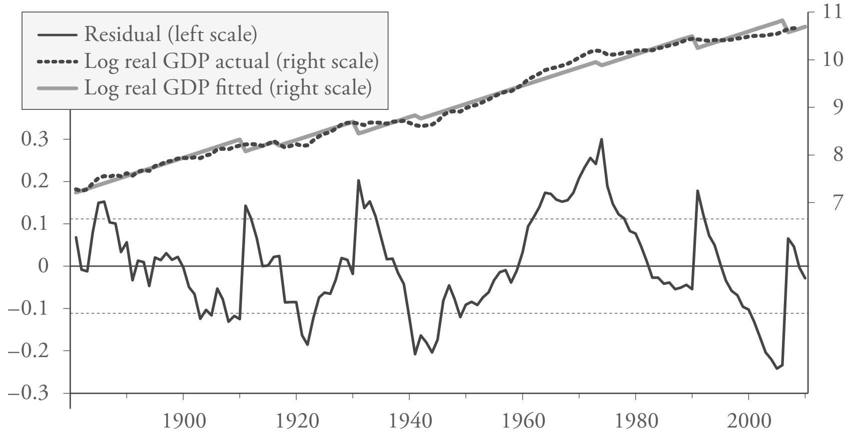
The very strong effect of the 1991 crisis may lead to the conjecture that this results from a slope break in the trend function after the oil crisis in 1973. In order to check the robustness of our results with respect to this specification we estimated

48 These observations are in line with the recent research of the IMF (2009) on recessions and CARMEN REINHART and KENNETH ROGOFF's (2009) investigations of banking-crisis recessions. Accordingly recessions resulting from banking crises tend to differ from recessions generally. They are more severe and drawn out and according to C. Reinhard and K. Rogoff are "associated with profound declines in output and employment".

an alternative model including a break in the slope in 1974 in the restricted model assuming the same effect of banking and non-banking crises, respectively. The corresponding estimate of the change in the slope was very small (–0.00034) and statistically not significantly different from zero (t-value = –0.678). In addition, the other regression coefficients estimates are essentially equal to those reported above.

The large negative coefficients of dummies for banking crises reflect the pattern observed in past banking crisis events. They are often motivated by the misallocation of capital in an overheated economy with asset price bubbles. These ex post misguided investments, financed by banks, then have to be written off, which corresponds to a reduction of the capital stock on the real side of the economy. As the crisis develops, banks become increasingly risk averse and credit for reasonable investments is difficult to obtain. Finally, the economy enters a deep and long-lasting recession accompanied by long-term unemployment and severe losses in human capital.[49]

Figure 5: Estimated Trend Model with Crisis Dummies, Real GDP, 1881–2010, Actual and Fitted Values, Residuals



49 The impact of 2007 banking crisis on Swiss GDP was relatively mild. As shown by the SECO a range of special factors contributed to this. The report points out that the Swiss economy was in a good state at the beginning of the banking crisis and well positioned to absorb shocks. Next, well-coordinated domestic monetary and fiscal policies mitigated the worst effects of the banking crisis on Swiss GDP. Finally, the Swiss economy also benefited from preventive actions taken by other countries. See SECO (May 15, 2012).

Our estimate of the economic costs of banking crises for Switzerland appears to be rather high. If we calculate the discounted sum of future GDP losses we arrive at a loss of 360% relative to pre-crises GDP (assuming a discount rate of 5% as used in a BIS survey). However, as documented in the BIS survey, GDP costs of banking crises are typically large with upper estimates exceeding 500% relative to pre-crisis GDP. The average cumulative GDP loss of all banking crises reviewed in the survey is above 100% relative to pre-crisis output.[50] Considering the importance of the banking sector in Switzerland, a material impact of banking crises on the Swiss economy is plausible.

5.2 The Impact of Higher Capital Requirements on the Annual Probability of Crises

Having estimated the severity of banking crises on Swiss GDP we now consider the annual probability of the occurrence of a banking crisis and its relationship to leverage. This second step is needed in order to calculate the expected benefits of decreasing leverage in the sense of reducing the expected GDP costs of banking crises. To this end we estimated a probit model for the occurrence of banking crises ($DBC = 1$) in Switzerland with the explanatory variables (denoted by X_i) leverage (large banks), interest rate spread (mortgage/savings rate), real GDP growth and inflation. For this purpose we decomposed the first three variables into a transitory or cyclical and a permanent or trend component using the HP filter. Inflation was decomposed into an expected (using an AR(2) model to predict inflation) and an unexpected inflation rate (the residual of the AR(2) model). All regressors were lagged one year in order to avoid simultaneity problems. Formally the model can be written as

$$\Pr(DBC_t = 1) = \Phi\left(\sum_i \lambda_i X_{i,t-1}\right) \tag{10}$$

where Φ is the normal distribution function and λ_i are parameters to be estimated.

Before turning to the estimation results let us briefly mention that the estimation and the interpretation of the "regression" coefficients in a probit model are different from standard regressions. The coefficients in our probit model show the effect of changes in the corresponding X-variable, for instance leverage, on

50 See BIS (August 2010), Table A 1.1, "Cost of a banking crisis relative to pre-crisis GDP" and Table 1.2, "Estimated costs of different crisis episodes: results of selected studies for a range of crises".

an unobservable index which is the argument of a normal distribution function. Therefore, the model cannot be estimated by least squares and we have to use maximum likelihood instead. If the coefficient is positive (negative) we have an increase (decrease) in the probability of banking crises with a positive change in the X variable. However, given the nonlinear S-shaped form of the normal distribution function the effect of a change in an X variable on the probability of a banking crises is not constant and depends on the level of X: i.e., it is small for low values of X, then increases and finally decreases when the index gets very large and the probability approaches 1. This pattern of influence on the probability of a banking crisis can be calculated for every X variable.

In the sequel we present the estimation results for this model using the leverage of large banks with Swiss data from 1906 to 2010.[51] We focus the estimation on large banks for two reasons. First, the discussion in Switzerland concentrates on the large banks and the systemic risk that they pose for a small country. Moreover, as noted earlier, the other banks already meet the higher capital requirements of Basel III. Finally, the estimation of the probit model for all banks using data from 1881 to 2010 provides similar results for all banks as the ones reported below for large banks. The available data dos not allow us to calculate leverage as assets to Tier 1 capital as in the cost analysis. Thus we use assets to equity as a measure of leverage. Assuming that equity and Tier 1 capital move consistently we can convert the equity-based results of the benefit analysis into the Tier 1-based cost analysis in noting that the ratio between equity and Tier 1 capital is 1.65. Thus, for instance, halving the Tier 1-based bank leverage from 46 to 23 corresponds to an equity-based reduction of bank leverage from 28 to 14.

The maximum likelihood estimates of the λ parameters obtained with data from 1906 to 2010 are reported in Table 7. For leverage and the interest rate spread only the cyclical component is statistically significant. An increase in cyclical leverage (interest rate spread) leads to an increase (decrease) in the probability of a banking crisis. The findings appear reasonable: A strong short-run increase in leverage and a cyclical decline in the interest rate spread are indicators for overexpansion, with fierce competition in the banking sector, and are typical of the euphoria paving the way to a bubble. The change in trend GDP (10% significance) and in expected inflation (5% significance) reduce the probability of a banking crisis. These results are in line with our a priori expectations. An increase in trend growth indicates that loans become less risky and the

51 Data for large banks are only available since 1906. The composition of this aggregate changed from eight (1906) to two banks (1998). Moreover, we should note that leverage is not adjusted to the change in accounting standards (switch to US GAAP).

incomplete adjustment of, in particular, sight deposit (demand deposit) interest rates to expected inflation eases the refinancing conditions of banks.

Table 7: Estimated Probit Model for Banking Crises 1906–2010

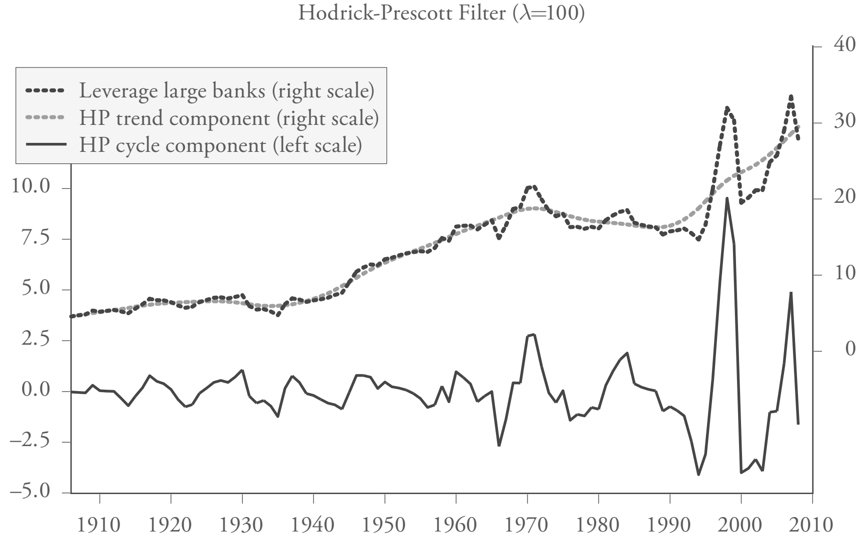
Regressor	Coefficient estimates, unrestricted		Coefficient estimates, restricted	
Intercept	–1.503	(1.445)	–1.987	(0.506)***
Leverage large banks, HP-cycle	0.515	(0.178)***	0.305	(0.111)***
Leverage large banks, HP-trend	0.156	(0.152)	–	
Interest rate spread, HP-cycle	–19.197	(6.079)***	–12.151	(3.670)***
Interest rate spread, HP-trend	–1.839	(1.881)		–
Change log GDP, HP-cycle	23.369	(18.207)		–
Change log GDP, HP-trend	–100.504	(55.243)*	–38.379	(23.201)*
Expected Inflation	–0.291	(0.142)**	–0.1380	(0.069)**
Unexpected Inflation	–0.015	(0.0623)		–
McFadden R^2	0.514		0.446	

Notes: *,**,*** indicates significance at the 5%, 1% and 0.1% level, respectively.
QLM Standard errors (Huber/White) (Newey-West) are given in parentheses.

The higher capital requirements under Basel III and the Swiss TBTF legislation do not primarily target the cyclical variability of the leverage but are designed to reduce leverage permanently, i.e., a reduction of the trend component is intended. Even if there is no direct significant effect of the trend component of leverage on the probability of a banking crisis there is an indirect impact resulting from the relationship between the variability of the cyclical component and the trend component of leverage. This is shown in Figure 6 for the large Swiss banks. This figure clearly suggests a positive relationship between the level of the trend component and the variance of the cyclical component. The higher the level of the trend component of leverage, the larger is the volatility of the cyclical component of leverage.

In order to explore this relationship we estimated a univariate time series model with a time variant conditional error variance including EGARCH and leverage trend effects for the cyclical leverage component. The EGARCH framework was used in order to account for possible asymmetric conditional variance effects suggested by the time series plots (positive shocks appear to have a stronger effect

Figure 6: Leverage of Large Banks HP-Filtered Trend and Cyclical Component



on variability than negative ones). The following estimated ARMA(2,1) model with normally distributed errors turned out to be appropriate. Standard errors are given in parentheses and the white noise property of the standardized residuals is tested by Q-statistics for the residual and the residual squared, respectively:

$$ll^c_t = \underset{(0.007)}{-0.005} + \underset{(0.060)^{***}}{1.340}\, ll^c_{t-1} - \underset{(0.062)^{***}}{0.713}\, ll^c_{t-2} - \underset{(0.007)^{***}}{0.970}\, \varepsilon_{t-1} + \varepsilon_t \tag{11}$$

$$\begin{aligned}\log(\sigma^2_t) = {} & \underset{(1.141)^{***}}{-7.235} + \underset{(0.197)^{***}}{1.169}\, abs\left(\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right) + \underset{(0.062)^{***}}{0.268}\left(\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right) \\ & + \underset{(0.449)^{***}}{2.238}\log(ll^t_{t-1})\end{aligned} \tag{12}$$

$$Q_\varepsilon(12) = 8.755,\ Q_{\varepsilon\varepsilon}(12) = 6.615$$

All the parameter estimates in the conditional variance equation are statistically highly significant (standard errors in parentheses). We see that the EGARCH-effects are asymmetric. The coefficient of the absolute standardized residual (1.169) is increased to 1.437 ($=1.169+0.268$) for positive residuals whereas it is decreased to 0.901 ($=1.169-0.268$) for negative residuals according to the conditional variance equation (12). Moreover, we note an economically and statistically significant influence of the trend component of leverage on the conditional variance of the cyclical component with an elasticity of 2.24. Thus, a permanent reduction in leverage decreases the variance of its cyclical component and therefore reduces the probability of large positive values of the cyclical component increasing the probability of a banking crisis.

Before turning to the use of equation (12) for calculating the dependence of the probability of a banking crisis on trend leverage it is worthwhile to mention an interesting implication of our finding that the cyclical component of leverage and not the trend component has a statistically significant effect on the probability of a banking crises. This finding suggest that is not the incentive effect (the ex-ante role of capital for risk taking) but the buffer effect (ex post capital allows to absorb losses)[52]. This finding supports the view of capital as a buffer as stressed by the Basel Committee. Moreover, it could be argued that our findings provide as strong argument for the countercyclical buffer, which applies to all banks. The countercyclical buffer is aimed at stopping the build-up of system-wide risk in periods of excessive credit growth. As a macro-prudential instrument it will be deployed by the national regulatory and monetary authorities only on a case-by-case basis. Whether the countercyclical buffer is the right tool in such situations is not clear. Too little is known about the implementation conditions and the potential operation of the countercyclical buffer. The buffer may slow down the build-up of leverage, but whether it is able to prevent excesses is questionable. The more appropriate medicine against leverage excesses consists of capital ratios that are sizeable enough to keep the trend leverage under control as quantified by equation (12).

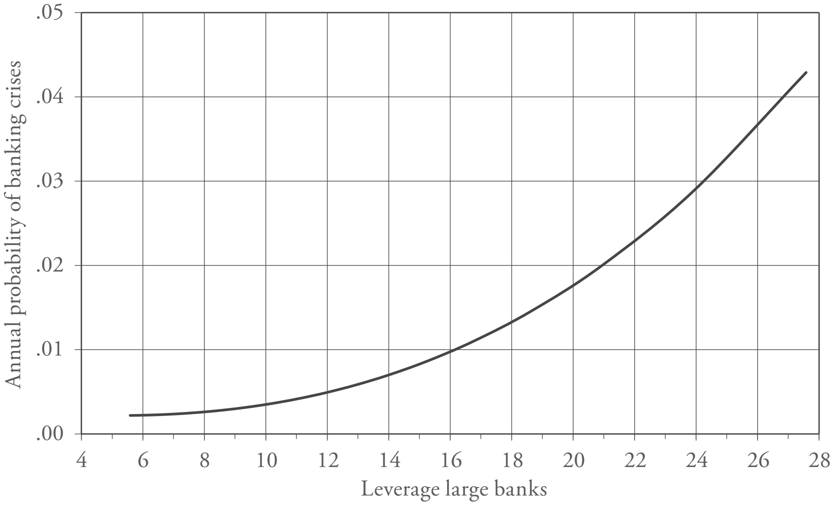
Figure 7 shows the probability of a banking crisis as function of the trend component of the leverage of large banks. This function was estimated as the mean of 50,000 Monte Carlo replications simulating the effect of the variability of the cyclical component of leverage on the probability of a banking crisis. That is, we calculated the conditional variance as a function of trend leverage ranging from 5 to 28 according to equation (11), and used these values to create the 50,000 Monte Carlo replications for the cyclical component of leverage for all values of trend leverage. These values were then used to arrive at the probability according to the restricted Probit model (10). In this context we have to take into account that, according to the ARMA (2,1) process, the variance of the cyclical component is larger than the variance of the error of equation (11). Given our ARMA parameter estimates the standard deviation of the cyclical component

52 We owe this observation to a referee.

of the leverage is 2.3 times the standard deviation of the error term. For these calculations, all other variables were kept at their long-run equilibrium level and expected inflation was set to 1%, confirming with historical experience since the mid 1990's and the 0 to 2% target band of the Swiss National Bank.

This exercise shows, as expected, that reduced leverage (higher capital levels) is associated with lower probabilities of banking crises. Reducing the leverage from 28 to 14 leads to a decrease of 3.6%[53] in the annual probability of a crisis (see Figure 7). Note also that the slope between crisis probability and leverage declines with lower levels of leverage. At high levels of leverage (low levels of capital) reductions in leverage (increases in capital) yield larger decreases in the probability of crisis than at low levels of leverage (high capital levels). This pattern is consistent with our expectations that the marginal benefits of higher capital levels decline with further capital increases.

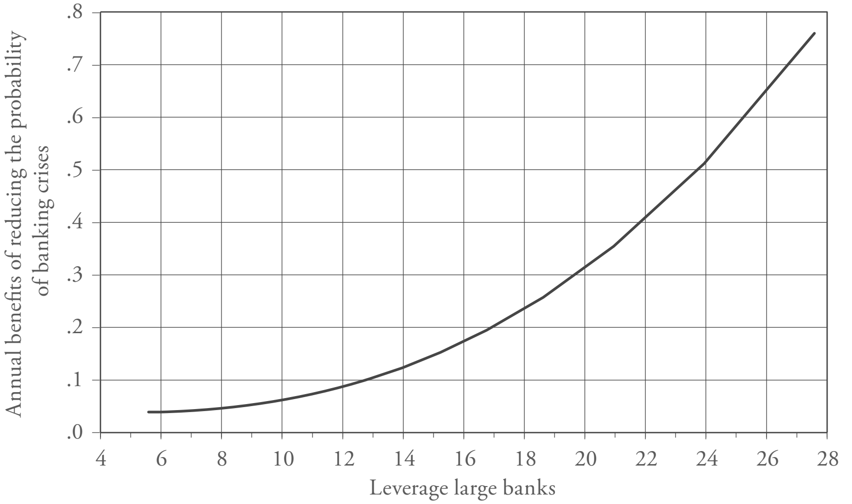
Figure 7: Estimated Annual Probability of Banking Crises and Leverage of Large Banks



53 The BIS (August 2010) survey shows that an increase of CET1 capital ratio by 100% (i.e. halving of leverage) leads to a reduction of the probability of banking crisis by 4.2%; see Table 3. The two estimates are not far from each other and one could expect that the crisis probability of Switzerland is lower than the experience of a panel of countries over a period of nearly 30 years (1980–2008).

The expected GDP benefits (in the sense of avoided costs of crises), is obtained by multiplying the probability of Figure 7 by 17.7% (the estimated GDP loss produced by a banking crisis) and is displayed in Figure 8. A reduction of the leverage by half (from 28 to 14) leads to a decrease in expected costs of banking crises by 0.64% of GDP (see also Table 8 in the next section). Note that this effect is permanent and that the discounted future GDP loss, at a discount rate of 5% (2.5%), is 13% (26%).

Figure 8: Expected Annual GDP Benefits and Trend Leverage of Large Banks



6. Cost Benefit Comparisons

The evidence presented in this article shows that a substantial increase in capital requirements for the Swiss banks will have no long-run negative effects on Swiss GDP. Different views confirm this finding. First, history shows that there have been periods where Swiss banks operated under much higher capital levels and yet lending spreads and growth conditions remained unaffected. Second, the econometric analysis confirms the presence of a strong M-M effect. Accordingly, substantial increases in capital requirements lead to a material reduction of the required return on equity, but only to a modest increase in cost of capital for banks. This is in line with evidence collected in other countries, in particular the USA and the UK. Furthermore, the majority of the Swiss banks already meet the Basel III standards and the conditions for the two large Swiss banks to pass on increases in (private) capital costs to the rest of the Swiss economy are not given. The conclusion is that warnings that substantially higher capital requirements would impede Swiss economic growth are not well founded.

The benefit analysis reinforces the case for substantially higher capital requirements. There is clear-cut evidence that higher capital requirements lead to a significant reduction in the annual probability of banking crises in Switzerland, associated with an annual reduction of GDP costs. Not unexpected but nevertheless striking is the evidence that recessions sparked off by banking crises have long lasting negative impacts on Swiss GDP growth that are larger than normal recessions. This makes it all the more important to reduce the probability of banking crises through appropriate measures, in particular higher capital requirements.

Table 8 summarizes our results. It shows the costs and benefits for a range of increases in CET1 capital ratios (50%, 100% and 150%) and the concomitant reductions of leverage (33%, 50% and 60%). An increase in the CET1 capital ratio of 100% (corresponding to a 50% decline in leverage) yields a reduction of the expected annual probability of 3.6% and an annual reduction of GDP costs of 0.64%. This would mean a benefit of 13% with a discount rate of 5%. On the other hand, the social costs of an increase of the CET1 capital ratio by 100% amount to only 0.044% to 0.050% or a drop of about 1% in present value. Thus, the long-run benefits exceed long-run costs by a significant multiple, suggesting that Swiss regulatory authorities would be well advised to implement the target capital ratios of Basel III and the Swiss TBTF legislation without any watering-down.

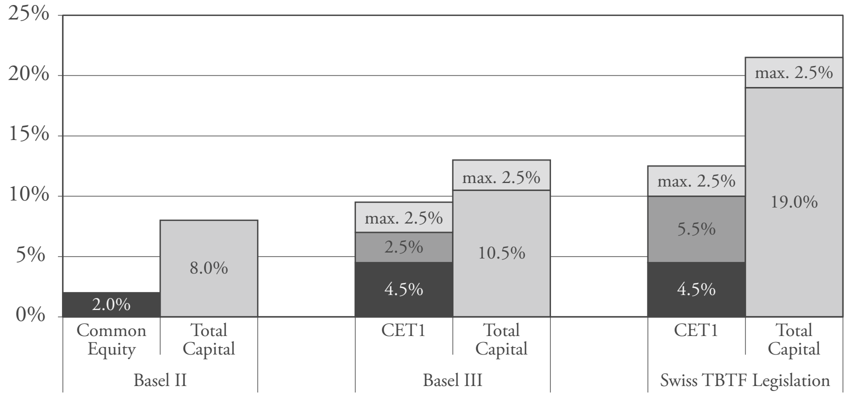
Table 8: Costs and Benefits of Increased CET1 Capital Ratios

		Social Costs		Social Benefits		
Change in CET1 capital ratio in %	Change in leverage in %	GDP impact	GDP Impact (discount rate of 5%)	Reduction in annual probability of crisis	Expected benefits (no discount)	Expected benefits (discount rate of 5%)
50%	–33%	–0.024 to –0.027%	–0.49 to –0.54%	2.9%	0.51%	10.2%
100%	–50%	–0.044 to –0.050%	–0.89 to –1.00%	3.6%	0.64%	12.7%
150%	–60%	–0.062 to –0.070%	–1.24 to –1.39%	3.8%	0.68%	13.6%

Annex 1: Capital Ratios under Alternative Regulatory Regimes

Apart from CET1 capital ratios there are other capital ratios that should be mentioned for the sake of completeness. Figure 9 shows the CET1 capital ratios in the context of the total capital ratios under each regulatory regime.

Figure 9: Capital Ratios under Alternative Regulatory Regimes



Total capital (Tier 1 capital plus Tier 2 capital) must be at least 8.0% of RWA at all times both under Basel I and II. However under Basel III banks must hold additional capital buffers: Banks must maintain at all times a capital conservation buffer of 2.5% of RWA and in times of excessive credit growth, a countercyclical buffer, which can vary between 0% and 2.5% of RWA.

The Swiss TBTF regulation requires for Systemically Important Financial Institutions a total capital ratio of 19% excluding the countercyclical buffer. This includes the minimum requirement of 4.5% and the capital conservation buffer of 5.5%, both consisting of CET1 capital. The remaining 9% consists of contingent capital (Wandlungskapital), which converts into shares on the occurrence of certain triggering events. There are two types of capital:

– High-triggering contingent capital securities that convert into shares or participation certificates (or are written down), if the CET1 capital ratio falls below 7% of RWA.

– Low-triggering contingent capital securities that convert into shares or participation certificates (or are written down), if common equity falls below 5% of RWA.[54]

Annex 2: Estimation of the CES-Production Function

As official capital stock figures for Switzerland have only been available since 1990, we had to estimate CES-production with data from the relatively short period 1991 to 2010. The data can be found on the website of the Swiss Federal Statistical Office.[55] The capital stock is measured in 1990 prices, and in order to make employment comparable, its trend is indexed to a 1990 base value equal to the wage sum.

The following estimation results for the CES and the Cobb-Douglas production function are based on this data:

$$\log(Y_t) = \frac{\log\left(\alpha K_{t-1}^{-\rho} + (1-\alpha) L_t^{-\rho}\right)}{\left(\frac{-1}{\rho}\right)} + \gamma t + e_t$$

Table 9: Estimation Results for the CES and the Cobb-Douglas Production Function

	CES		Cobb-Douglas	
α	0.301	(0.072)	0.306	(0.072)
ρ	0.0086	(0.441)	A priori 0	
γ	0.0064	(0.00089)	0.0063	(0.00085)
R^2	0.988		0.988	
Se residual	0.011		0.011	
Durbin Watson	1.136		1.134	

Notes: Estimated standard errors in parentheses.

54 For details see the Regulierungsfolgenabschätzung (March 2011) or a short summary in FINMA Annual Report (2011).

55 (http://www.bfs.admin_ch/bfs/portal/de/index.html). The employment figures are from the Monthly Statistical Bulletin of Swiss National Bank (http://www.snb.ch/de/iabout/stat/statpub/statmon/stats/statmon/statmon_N1_1).

The elasticity of substitution is calculated as $\sigma = 1 / (1 + \rho)$ and the corresponding estimate is 0.992 (se = 0.433). Therefore the CES function essentially turns out to fulfill the Cobb-Douglas restriction of a unit elasticity of substitution and the corresponding estimates are only marginally different from the unrestricted CES estimate.

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SUMMARY

So far the discussion in Switzerland about the social costs and benefits of higher capital requirements resulting from the new Basel III Accord and the Swiss Too Big To Fail legislation has been heavily qualitative. This paper provides a quantitative view and estimates the long-run costs and benefits of substantially higher capital requirements using empirical evidence on Swiss banks to assess both benefits and costs. The analysis yields two main conclusions. The long-run economic benefits of higher capital requirements are substantial for the Swiss economy leading to a significantly lower probability of banking crises and associated expected losses. In contrast the costs of higher capital requirements as reflected in increased lending spreads and potential output reductions are literally non-existent.