A CRITICAL EVALUATION OF THE SENSITIVITY OF A BANK'S BALANCE SHEET TO CHANGE WHEN OPTIMIZING FOR CAPITAL REQUIREMENTS UNDER BASEL

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Abstract

The management of a modern bank is a complex task that is becoming increasingly more so due to the inherent complexities of its business and of an ever changing modern financial environment. Recent turmoil in the global financial environment necessitated new regulation, some of which may have a material impact on the structure and management of a bank. The establishment of higher minimum capital buffers for banks to counter the possibility of failing will have a material influence on profitability. Apart from making investment in banks shares less attractive, the regulation may turn out to be bad for global economic growth. In view of the above, the objective of this research was to single out and demonstrate the effect of the minimum capital requirements on the profitability, composition and size of a bank balance sheet. The Simplex algorithm was used to set up a goal programming problem formulation in Excel. Different capital minima was entered in the model and then optimised to observe the effect on the bank balance sheet size, composition and profitability. The research clearly demonstrated that at a capital reserve requirements of 5%, the resulting balance sheet is 190% of the original balance sheet size and at the 25% capital reserve requirement the new balance sheet is merely 57% of the original size. Increasing the reserve requirement from say 5% to 9,5% gives rise to approximately 40% change in balance sheet size, all other things being constant. As the capital reserve requirement is increased from 5% of RWA to 14%, the profit falls from over R60 billion to just over R10 billion. It is clear from the research that banks are very sensitive to the new regulation. It also underlines how difficult it may be for banks to maintain profitability. The changes needed to maintain the profitability, may not be possible/feasible in the South African financial environment. The time is possibly right now for banks to start improving efficiency and developing new innovative low risk high return services and product lines.

Keywords: Capital; Reserves; Optimisation; Objective function; Liquidity

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Introduction and problem formulation

The management of a modern bank is a complex task that is becoming increasingly more so due to the inherent complexities of its business and of an ever changing modern financial environment. This has recently again been underlined by the Sub-Prime crisis. The primary reasons why banks failed, was due to excessive risk taking which came in many different forms, for an example, undue credit granting to risky clients, excessive gearing, undue derivative risks and add to this the collective actions of many global banks. Due to the interrelated nature of global financial markets, banks were all affected in some way or another.

The primary risk that banks take is credit risk. It can easily be argued that the American banks set aside the very fundamental investment and business principles of being rewarded for taking high risk. Of course, human behaviour had a lot to do with the magnitude of the crisis. That is, for high risk, a high return is sought or that was what we were led to believe. The fundamental problem with the sub-prime loans was that these loans should, from a risk/return perspective, never have been granted in the first place. Put differently, credit granting standards deteriorated. The fundamental problem of these loans was that the borrower put very little or no equity into the loan agreement due to very limited private wealth. Due to this, excessively high loan to asset ratios (even 1) were needed to be able to grant these loans. This situation meant that banks were not rewarded for the risk they took. The problem is really that the lender (a bank) can, in case of default, fall back on a property that is already 100 per cent financed. Furthermore, the lender can also not add an interest premium to the loan rate to cater for the high risk as this will make repayments even more difficult for the borrower which may already be cash strapped. It is by now clear that this was, from a bank management perspective, an undesirable situation.

Apart from the fact that undue credit was granted by many US banks, many other risks were also amplified after the crisis. Most important of these was liquidity risk. The credit problems led to large losses by highly levered banks which were exacerbated by loan defaults. This led to funding problems. Market liquidity deteriorated due to levered banks trying to lower leverage. In an attempt to lower counterparty exposure, banks started selling assets, hoarding cash and improving or tried improving their risk management processes/positions. All this gave rise to interbank funding problems with TED spreads widening. TED is the acronym derived from the T-bill and Eurodollar futures ticker which is ED. The TED spread is the difference between the interest rates on interbank loans and on short-term U.S. government debt ("T-bills"). The TED is an indication of the perceived credit risk in the general economy. An increase in the TED goes hand in hand with an economic downturn and lowering liquidity in the market.

Banks experienced funding liquidity problems which quickly spread, affecting highly levered hedge funds also creating funding risk for them where banks refuse to lend. The market illiquidity, the prospect of further liquidity risk and possible bank failures, scared investors. Prices dropped, especially those of illiquid assets with high margins. The crisis also spread across all asset classes and markets globally even affecting Covered Interest Rate Parity and the possibility for arbitrage.

Recent events in the global financial environment underlined just how vulnerable banks can be and just how easily they can fail - and they are certainly not too big to fail. The Basel III Accord, among others, proposes that banks increase the size and quality of their capital buffers to absorb losses. Apart from this, liquidity positions and management must also improve substantially in the years to come. Although increasing the capital buffers may seem to be the way for the future, it may, in the long run, not be the case. If the capital buffer is increased, banks will have to increase risk to increase the ROE. It won't be long before banks again start taking on more risk or will seek other innovative ways of bypassing regulatory requirements so as to deliver the ROE that owners want and in doing so, increase risk as these two things go hand in hand.

Objectives of the research

Since so many financial magnitudes affect the balance sheet of a bank simultaneously, knowing how the balance sheet should look in future is difficult to determine. The bank balance sheet is affected in a unique way by market factors. The degree of interaction between the asset and liability sides of the balance sheet is quite profound, more so than in case of any other businesses. However, we are fortunately not left entirely in the dark about the structure of the balance sheet. Many modern tools exist which may help us model and achieve some reasonable answer to the question of the structure of the balance sheet.

The objective of this research is briefly as follows:

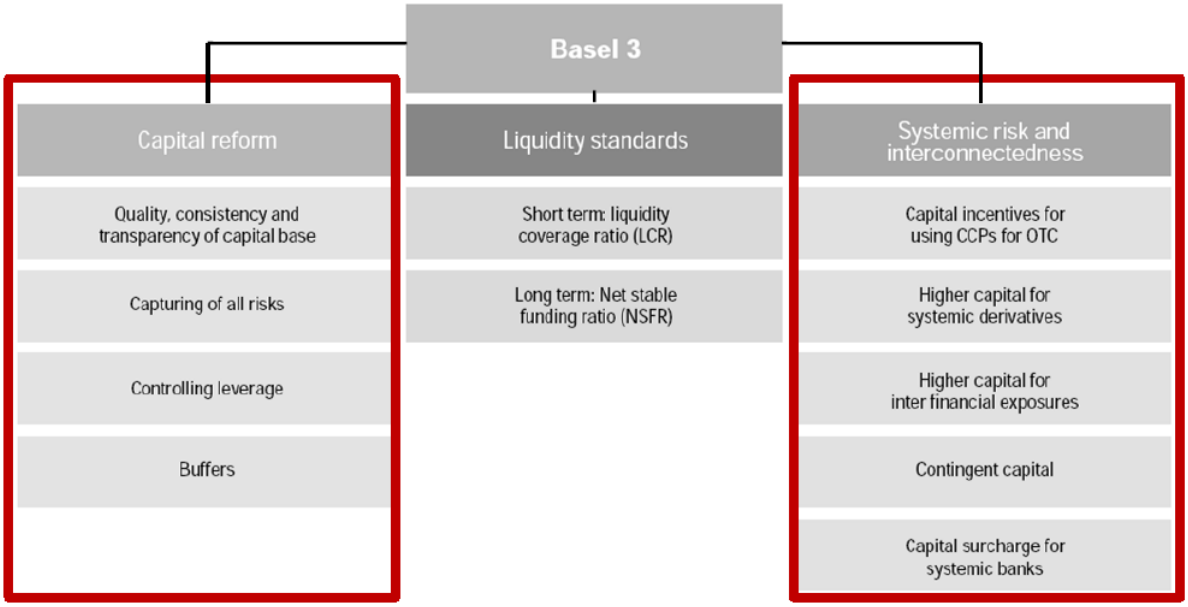
- To develop a simple multi-objective, goal programming bank balance sheet model which will be used to demonstrate how the capital requirements will affect balance sheet size and profitability. The model will also demonstrate that the size of the capital buffer is not straight forward to determine.
- Another sub-objective of this research is that the model developed here, will serve as a prototype for the development of a more complex bank balance sheet planning model in the foreseeable future.

A discussion of aspects such as the effectiveness of some of the Basel measures is outside of the scope of this research. Financial aspects other than capital and profitability will not be covered in this research.

Literature Review

The recent financial crisis demonstrated just how interrelated and vulnerable financial markets can become. The collective actions and risks to which banks were exposed, underlined the weakness of the Basel II accord. This led to the third Basel Capital Accord (Basel III) which represents one of the biggest changes to banking regulations that the financial world has seen (Barfield, 2011:1). With the main aim of creating a resilient banking sector (BIS, 2010:1), this accord has been and is being implemented by the Basel Committee on Banking Supervision as a direct response to the recent financial crisis of 2007 (King & Tarbert, 2011:1). According to Barfield (2011:10), banks entered into the financial crisis with insufficient capital, high leverage ratios, and financial assets carrying too high a level of risk. This led to a large number of bank bailouts and failures and resulted in the current unstable state of the banking sector. The Basel Committee plans to achieve its stated aims of resilience and financial stability (Barfiel, 2011:9) by strengthening regulations and raising requirements on capital and liquidity (BIS, 2011:1)(see Figure 1 below).

Figure 1. A breakdown of the Basel III requirements



Source: KPMG (2010:9)

The Basel Committee anticipates that new regulations will lead to a safer banking sector in the future, with banks holding elevated levels of capital and lower levels of risk (De La Mora, Matten & Barfield, 2010:2). The Basel III regulations on capital could, however, have a negative impact for shareholders, consumers and bank profitability, and it may have a destabilising effect on the financial system (De La Mora, Matten & Barfield, 2010:2).

The issue of bank capital management is not new to the banking sector. Since the initiation of the First Basel Accord in 1988, the Basel Committee has had the *same* objective of achieving a sound and stable international financial system (Jackson et al, 1999:1) and has used the *same* major technique of regulating bank capital to do so. The First Basel Accord was unsuccessful, and as a result, the second accord (Basel II) was implemented 26 years later (King & Tarbert, 2011:1-2). The Basel Committee, however, also failed in this attempt (Blundell-Wignall & Atkinson, 2010:5) due to the fact that the recent financial crisis severely affected the economy and left the banking sector unstable, despite the Basel II regulations being in place. From this, the Basel Committee has concluded that past regulations have been insufficient and that an even higher minimum capital requirement should be implemented. Although Basel III aims to improve on the earlier accords, their previous failures raised some doubt regarding the Basel Committee's approach and the effectiveness of continually raising capital requirements. The advantages of Basel III seem simple: holding a larger capital buffer will result in a banking sector that can easily absorb losses and remain stable in a period of financial distress (King & Tarbert, 2011:3). Banking regulation is, however, complex and the costs involved with adhering to capital requirements frequently outweigh the seemingly obvious advantages. Under Basel III, banks will need to optimise their capital and carefully plan their actions in order to facilitate the crucial restructuring of the banking system and the resetting of their business models necessary to adjust to the revised capital regulations. This will inevitably have cost and time implications, resulting in the necessity for banks to start this process earlier rather than later (De la Mora, Matten & Barfield, 2010:5). This immediate reaction is needed even though Basel III will only be fully implemented by 2019 (Chan, Masters and Hingel, 2010:1), with the requirements being gradually increased and enforced. According to the Basel Committee, the reason for this staggered implementation is to allow for economic recovery (King & Tarbert, 2011:11) and also to give banks enough time to adjust to the regulations at the lowest possible cost (Kowalik, 2011:5). Although this seems beneficial, the main problem may concern the actual requirements, not merely the timeframe of implementation.

There is a substantial amount of information supporting, as well as criticising, capital requirements with numerous conflicting views. The Basel Committee has recently conducted a Quantitative Impact Study to assess the effects of the new regulations. This study has suggested that Basel III will have minimal negative effects (Lyons & Casey, 2011:29) but this represents only one side of the capital requirement argument. This research

discusses the (optimal) level of capital and determines the impact of the necessary bank reform, providing a critical view on Basel III. These regulations will affect a large number of banks on a global scale and it will, therefore, be beneficial for banks and governments, as well as investors, to be conscious of the impact thereof.

Banks and capital requirements under Basel III

A bank is a financial establishment that is based largely on leverage, with banks borrowing from the market and lending to borrowers (King and Tarbert, 2011:1). According to Kowalik (2011:1), banks fund their investments by using deposits, other debt and equity capital. Often not enough equity capital is held, because this represents money that cannot be invested to earn a return and is, thus, costly for banks (Paletta, 2010). Capital is an important and critical concept of banking and it can be defined as the portion of the bank's assets that is not contractually bound to make repayments (Elliot, 2010:3). The conventional role of capital is to ensure that banks can survive unexpected losses and that these losses can be absorbed internally without affecting the economy as a whole. This is, however, not the sole purpose of capital as excess reserves also play a fundamental role in the credit rating assigned to banks and the confidence of investors in the financial institution (Kjeldson, 2004). Higher credit ratings are assigned to banks with stronger capital positions and this leads to lower financing costs charged on interbank loans, as well as lower interest rates on bonds issued by the bank. Capital reserves also enable a bank to enter into large exposures without having to raise additional capital and maintain the reputation of the institution (Kjeldson, 2004). An aspect that should also be considered is a particular bank's appetite for risk and its policy towards risk taking. The risk culture in a bank has a lot to do with how it will deal with risk and how it maximises profit.

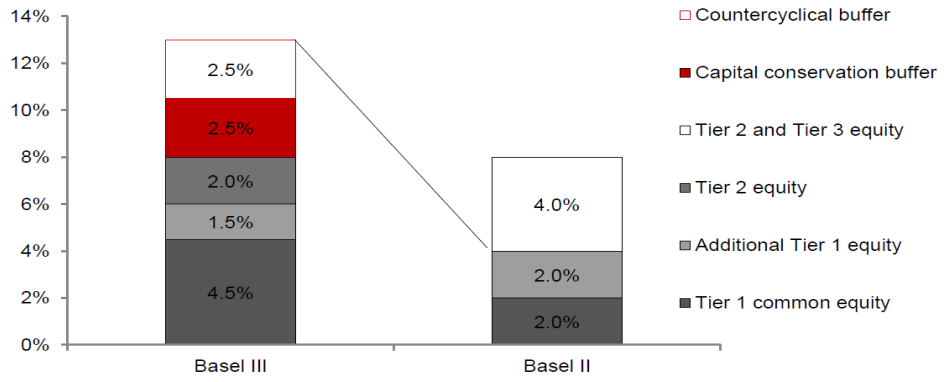
Regulations on bank capital aim to ensure that the excess reserves held by banks are sufficient to absorb losses and that these additional funds add value to the institution. According to the Basel Committee, it is crucial for banks to back their risks with a high quality and quantity of capital and this has resulted in the need for establishing the Basel Accord (BIS, 2010:2). Regulation is defined as a "set of rules and standards that govern financial institutions" (Barfield, 2011:5) and this is exactly what Basel III aims to do.

The key elements of the Basel III framework include:

Type of capital	Percentage of RWA
Minimum capital (Tier 1)	4,5%
Capital conservation buffer	2,5%
Counter cyclical buffer	2,5%

Firstly, the new regulations require banks to hold a minimum level of capital, consisting entirely of Tier 1 capital, equivalent to 4.5% of risk weighted assets (BIS, 2010:12)(see Figure 2 below). Tier 1 capital is the highest quality, support-providing capital (Lyons & Casey, 2011:1) and consists of common equity and retained earnings (Shearman & Sterling.2011:4). Risk weighted assets (RWAs) involve the assignment of an inclusion percentage to assets based on their perceived level of risk (Kowalik.2011:2), with riskless assets carrying a weight of 0% (King & Tarbert, 2011:1).

Figure 2. A breakdown of the total capital requirements compared under the Basel III and Basel II regulations



The fundamental definition of capital will be strengthened and applied uniformly on a global scale under Basel III (King & Tarbert, 2011:3). The main aim of this is to ensure consistency and transparency amongst all internationally active banks.

The Basel Committee has identified additional regulations, which will be implemented over and above the minimum capital requirements, to close the loopholes evident in Basel II (The Economist, 2011:2). These additional requirements are comprised of a capital conservation buffer of 2.5% of RWAs and a countercyclical capital buffer of up to 2.5%, depending on the state of the economy (Shearman & Sterling, 2011:3). A leverage ratio of at least 3% will also be introduced under Basel III (King & Tarbert, 2011:6).

Setting the capital requirement at an appropriate level is a difficult task. If the capital requirements are too high, banks will become unprofitable. This will lead to an increased cost of borrowing, which will, in turn, slow down economic growth (The Economist, 2011:1). On the other hand, capital requirements set too low will lead to banks being vulnerable and susceptible to failure (The Economist, 2011:1). Many, vastly different opinions on the appropriate levels of capital exist. Miles, Yang and Marcheggiano (2011:40) believe that the capital requirement should be set at 20% of RWAs, almost triple the level suggested in Basel III. The banking industry, on the contrary, believes that the Basel III requirements, which have already almost tripled, are too high, with more modest changes being appropriate (Elliot, 2010:9).

The measurement of the required level of capital, in relation to RWAs, has also been identified as problematic. Firstly, the practice of assigning a risk weighting to assets has been widely criticised, with certain arguments suggesting the elimination of this approach altogether (King & Tarbert, 2011:3). Basel III allows sophisticated banks to use internal risk models to determine various risk weightings and in doing so, ultimately determine the capital levels held (Elliot, 2011:8). The main problem with this approach is that weightings are often based on limited historical data and are determined in the bank's own interest (Elliot, 2011:8). These risk models are also often not stress-tested, resulting in insufficient capital in a financial crisis (The Economist, 2011:1) and a largely flawed system. Secondly, RWAs focus on individual assets and are, therefore, portfolio invariant. This is seen as a disadvantage because the importance of diversification is not reflected and the concentration of a portfolio in one asset is not penalised (Blundell-Wignall & Atkinson, 2010:4). Basel III does not address the fundamental problems found regarding the use of RWAs as has become evident in the previous accords (Blundell-Wignall & Atkinson, 2010:10).

The return on equity (ROE) is a measure of a bank's profitability in relation to shareholders' equity. This is a fundamental measure for shareholders as it indicates the quality of the shares and reveals how well a bank is utilising its funds to generate returns (Business: The Ultimate Resource, 2009). Banks should aim to keep their ROE as high as possible, but this proves to be difficult with the increase in equity required by the Basel III regulations. According to Barfield (2011:14), a falling ROE can negatively change the perception investors have of banks, and shareholders often fear that a bank is struggling when common equity is offered to the public (Kowalik, 2011:3). Issuing more equity also results in the dilution of shares values, which will not appeal to investors as their earnings per share will decrease. These factors make it difficult for banks to generate common equity and increase their Tier 1 capital, at a time when it is specifically required by regulations. Banks will be forced to take less desirable actions in order to meet requirements, while aiming to continue satisfying shareholders and minimising costs. Instead of issuing more capital, banks will be inclined to decrease the supply and increase the cost of loans to meet the Basel III standards (Kowalik, 2011:3) (Elliot, 2010:11). This will likely have a negative impact on economic growth and recovery.

Alternatively, banks can also attempt to maintain their ROE by raising profits, forming one of the main arguments against Basel III. Banks cannot earn a higher return through the use of risk free assets. These assets may have a 0% weighting with regard to RWAs (Kowalik, 2011:2) and, therefore, require no capital, but these assets also generate a low return. With the need to increase profitability, banks will move their funds to riskier parts of the economy (The Economist, 2011:1), being forced to hold higher levels of capital, but also being exposed to the possibility of earning higher returns. This, once again, causes problems for the stability of the banking sector and counteracts the safety created through the increase in capital, defeating the objectives of the Basel Accord as it relates to capital.

There is little dispute that the increased capital requirements will increase the cost of borrowing and in doing so, slow economic growth. There is, however, disagreement regarding the magnitude of the harm that Basel III will cause (The Economist, 2011:4). According to The Economist (2011), the Institute of International Finance estimates a decrease in economic growth of up to 0.9% per percentage point of capital held, while the New York Federal Reserve estimates a decrease of 0.09% and The Basel Committee expects even less than this.

The slow economic growth expected under Basel III, can be attributed largely to the increased cost of borrowing, the decrease in loans offered, and the resultant plunge in the money supply (The Economist, 2011:4). Adjusting to capital ratios is costly for banks, and according to Kowalik (2011:5), banks prefer to raise their capital ratios by decreasing lending instead of increasing equity capital. This, however, could cause a credit crunch and will undoubtedly decrease economic growth (Kowalik, 2011:5) due to the lack of money in the financial system. The economy is presently in the process of recovering from the recent financial crisis and a slow economic growth is, therefore, undesirable in the current state of the financial sector. According to Professor Tim Congdon, the main reason for the decrease in the money supply and the failure to recover from the financial crisis to date, is that "regulators...are pressing banks to raise capital asset ratios and to shrink their risk assets" (Evans-Pritchard, 2010).

It is important to realise that banks take time to adjust to capital ratios (Kowalik, 2011:5) and as a result, the Basel Committee has designed a timeframe in which the regulations on capital are implemented gradually (Lyons & Casey, 2011:1). Regardless of this, however, these regulations will be costly to banks and only really make sense in times of credit expansion and monetary growth (Brown, 2010). As the economy is currently in a trough, these ideal conditions do not exist and the new Basel Accord could ultimately harm the economy and limit growth, making this an important topic for discussion in the management of bank capital under Basel III.

Additional requirements under Basel III

The first and second Basel Accords focused solely on micro-prudential factors, but Basel III has implemented a range of additional requirements in order to attain a broader range of macro-prudential goals (King & Tarbert, 2011:3). Over and above the minimum capital requirements discussed, conservation and countercyclical buffers, a leverage ratio, will be introduced (Lyons & Casey, 2011:25). According to Ojo (2011:15), the conservation and countercyclical buffers have the main aim of protecting the banking system from a build-up of risk, which can be directly linked to excessive credit growth. These buffers essentially raise the capital requirements to an even higher level, and in doing so, exacerbate the possible harmful effects of Basel III on the banking system and the economy. The leverage ratio is supplementary to the basic Basel III requirements and acts to provide a last resort, or 'backstop' of support to the risk weighted capital requirements (Lyons & Casey, 2011:24).

Additional requirements have been introduced under Basel III with the aim of achieving a resilient banking sector and a macro-prudential focus (King & Tarbert, 2011:3). The conservation and countercyclical buffers increase the amount of capital banks are required to hold in an economic boom, resulting in capital reserves that can be used to absorb losses in an economic downturn (Kowalik, 2011:1). A leverage ratio has also been introduced to account for all on- and- off balance sheet leverage in an attempt to prevent the de-leveraging of banks in a financial crisis (Lyons & Casey, 2011:26). Although these additional requirements seem beneficial, they each have their own drawbacks in practice and essentially double the minimum capital requirement proposed. These buffers could have advantages, but it was necessary to determine if the costs outweigh the gains.

It was and is still evident that a large degree of uncertainty exists regarding the new capital requirements under Basel III. The Basel III framework proposes some fairly drastic changes and the reason that this research was undertaken was to form a clear, critical picture of the new regulations and their effects on the balance sheet only.

Strategic Balance Sheet and Risk Management

In the banking context, balance sheet management may briefly be defined as follows:

Balance sheet management entails considering conflicting and competing objectives such as maximization of income/profit as opposed to minimizing financial risks associated with alternative portfolios (Tayi & Leonard : 1988). Although this definition is dated, it still applies today. However, the complexity of financial markets have drastically increased, markets in different countries are more integrated/linked together thereby influencing each other more than ever and all markets are more volatile. Financial products traded and offered to clients also had to become more complex due to the more complex management problems.

Looking at the liability side of the balance sheet, it is clear that the primary business activity of a bank entails receiving money (deposits) from the general public (retail market) which are loanable funds. Deposit activities are often intricately linked to economic activity (e.g. interest rates, propensity to save), product ranges offered, services offered and competition between banks.

Another important item on the liability side of the balance sheet is the capital and reserves (Tier 1 Capital). Capital refers to the capital raised from issued shares. Reserves represent the accumulative profit carried forward from one year to the next. The relative size of the capital and reserves is seen

as very important to safeguard the bank against failure (as seen during the financial crisis) and is, at the same time, very controversial due to its effect on profitability. Increasing the issued share capital, of course, reduces the ROE. Increasing the capital buffer with the reserves component is dependent on the bank's ability to generate profits through its core business. Apart from the capital requirements, the new regulatory risk weighted assets, maturity matching and liquidity requirements limit the ability of banks to take on risk and increase the ROE/ROA. To complicate thing even more, the economic environments have undergone change, leading to the reduced ability of clients (whether corporate of private) to save.

The following important item on the liability side of the balance sheet is borrowed funds which is often used as a long-term source of funds. It is also used to leverage the return on the shareholder's funds, if the bank succeeds in earning more with the borrowed funds than what it pays for it.

On the asset side of the balance sheet the primary source of income is from loans and advances which may make up anything between 70 and 80 percent or even more of the total balance sheet. The loans and advances are quite diverse. These include secured loans such as housing loans, unsecured loans such as credit card loans, loans to corporates and personal loans. Other assets are funds locked up in cash, traded instruments (e.g. bonds, derivatives) and other investments.

When a bank attempts to manage its balance sheet on a strategic level, that is, over an extended planning period of say 36 to 60 months, it needs to look at the source(s) of funds, how much can it get hold of and how those funds will be allocated to the different asset classes that will generate its income. Over this planning period, the bank should also consider how it would want to change its position in the market to gain competitive advantage and gain market share or reposition it so that it may substantially reduce risk or say introduce new profitable product lines. It therefore has to consider how to strategically allocate the funds to different asset classes on a risk and return basis. Funds may be allocated to these classes in accordance with various factors that are usually linked to the economic environment and the bank's own internal constraints and management policies. In South Africa, the financial markets and the change that the markets can undergo, is limited due to the size of the market and the profile of the depositors.

The interaction between the asset and liability sides of the balance sheet, in the case of a bank, is unique. The structure of both sides of the balance sheet has to be considered together. Of course, the starting point of the balance sheet planning is to decide what funds the bank may in future receive (wholesale or retail). However, it is not to say that the bank should let the balance sheet constantly increase in size or grow. It may even want to reduce the size of the balance sheet to be able to maintain the ROE, the capital requirements and liquidity requirements. In the next section the model will be formulated. This is then followed up by an illustration of the model outcomes and a brief discussion.

Balance sheet planning model formulation

As the models that may be formulated to determine the future balance sheet structure, may vary substantially in terms of complexity and focus, it stands to reason that the most important variables that will materially influence the future position and profitability of the bank, must be used within the framework of the requirements of Basel III. It is not possible to consider all possible variables as this would make the model exceedingly complex. Any additional benefits that will be gained with additional complexity may be very marginal. Increased complexity may also lead to increased model risk.

The primary objective of an optimization model may, on the one hand, be to maximize the shareholder's wealth. On the other hand, the bank should attempt to minimize risk within a given framework. If risk is minimized, the return on equity is affected negatively. The purpose of this research is to elucidate the questions about the capital buffer level only.

The research instrument utilised in order to collect primary data in this investigation takes the form of a simple, single objective linear programming model developed in Microsoft Excel. A model is defined as a "representation of a [real world] system that is constructed to study some aspect of the system as a whole" (Blumberg, 2011:36).

The model utilised in this research operated by inputting a summarised bank balance sheet (of ABSA bank in particular) into Microsoft Excel and allowing this financial statement to be modified and projected in order to optimise the allocation of assets and liabilities and equity under various scenarios while maintaining the RWA and liquidity regulatory requirements. Symbols have the following meaning:

A = Asset
L = Liability
RW_i = Asset risk weight for A_i
R_i = Per period interest rate for asset A_i or liability L_i for period j
m = number of liabilities and equity
n = number of assets
o = number of goals
$i = i_{th}$ asset or liability

j = j_{th} period j of the planning or forecasting period

s = short-term

m = medium-term

l = long-term

Objective function:

A standard optimisation model would attempt to optimize the net interest income as follows:

$$Z = \text{Max} \quad \left(\sum_{i=1}^{n}(A_j xR_j) - \sum_{i=1}^{m}(L_j xR_j)\right)$$

However, a simple, goal programming model formulation requires that the model "optimizes" the balance sheet by minimizing the deviations (d_j^+, d_j^-) from the stated goals. The user sets a goal for net interest income. The model then is used to structure a future balance sheet that will be as close to the profit goal as possible. Therefore, for this research, the following objective function was minimized:

The objective function is restated as follows:

$$Z = \text{Min} \qquad \sum_{i=1}^{o}(d1_j^+ + d1_j^-)$$

Where d1 is the deviation variable applicable to goal 1 for period j. The plus sign "+" indicates an over achievement of goal 1 for period j. The negative sign indicates an under achievement of goal 1 for period j.

Subject to all decision variables being nonnegative:

$$A, L \geq 0$$

Table 1. Mathematical formulation for decision variables

Line item in balance sheet (decision variables)	**Decision variable value determined by lower and or upper bound or equal to constraint**
Liabilities: Other than deposits and capital (not changed by LP model. Balances are kept static and equal to the opening balance sheet values.)	
Deposits from banks	L1j = opening balance
Trading liabilities	L2j = opening balance
Derivative liabilities	L3j = opening balance
Hedging liabilities	L4j = opening balance
Deposits: Short-term	No limitation: L5sj ≥ 0
Deposits: Medium-term	No limitation: L5mj ≥ 0
Deposits: Long-term	No limitation: L5lj ≥ 0
Debt securities in issue	L6j = opening balance
Normal tax	L7j = opening balance
Liabilities under investment contracts	L8j = opening balance
Policyholder liabilities under insurance contracts	L9j = opening balance
Borrowed funds	L10j = opening balance
Other liabilities and sundry provisions	L11j = opening balance
Deferred tax liabilities	L12j = opening balance
Share premium - Preference shares	L13j = opening balance
Shareholder's equity: Capital and accumulated reserves at end of period j	$\sum_{i=1}^{n} R_j A_j$ - $\sum_{i=1}^{m} R_j L_j$ - ($L14_{(opening)}$ x (1 + per period ROE% for period j) = 0
Minority interest	L15j = opening balance
Minority - Barclays	L16j = opening balance

Assets: Loans and advances and other assets	
Cash, cash balances and balances with central banks	L1j ≥ % of $\sum_{i=1}^{m} Lj$
Statutory liquid asset portfolio	L2j ≥ % of $\sum_{i=1}^{m} Lj$
Loans and advances to banks	A3j = opening balance
Trading assets	A4j = opening balance
Derivative assets	A5j = opening balance
Total hedging assets	A6j = opening balance
Loans and advances to customers - short term	No limitation: A7sj ≥ = 0
Loans and advances to customers - medium term	No limitation: A7mj ≥ = 0
Loans and advances to customers - long term	No limitation: A7lj ≥ = 0
Reinsurance assets	A8j = opening balance
Other assets	A9j = opening balance
Investments	A10j = opening balance
Subsidiary shares	A11j = opening balance
Investments in associated undertakings and joint ventures	A12j = opening balance
Intangible assets	A13j = opening balance
Property and equipment	A14j = opening balance
Current tax assets	A15j = opening balance
Deferred tax assets	A16j = opening balance

Table 2. Mathematical formulation of other additional constraints

Accounting constraint	
Total assets = total liabilities	$\sum_{i=1}^{n} Aj - \sum_{j=1}^{m} Lj = 0$
Level of liabilities of planned balance sheet is equal to the level of the opening balance sheet	$\sum_{i=1}^{m} L_{(opening)} = \sum_{i=1}^{m} L_j$
Regulatory constraints:	
Maintenance of capital buffer	
Capital asset ratio (CAR): Shareholder's capital + retained earnings + forecast period growth must be ≥ prescribed % of Risk Weighted Assets (RWA)	$(L14_{(opening)}$ x (1 + per period ROE% for period j)) ≥ Minimum capital % x ($\sum_{i=1}^{n} Aj \ x \ RWj$)
Maturity Mismatch	
Short-term loans must be a percentage of short-term liabilities	AL5sj - % of L7sj = 0
Medium-term loans must be a percentage of medium-term liabilities	AL5mj - % of L7mj = 0
Long-term loans must be a percentage of long-term liabilities	AL5lj - % of L7lj = 0

It is important to note that the Deposits due to customers and Loans and advances to customers are left open to fluctuate. All these decision variables have lower bounds only, i.e. they are set ≥ 0. The size of the balance sheet is therefore dependant only on the level at which the model can satisfy the profit goal (minimise the deviations), satisfy the accounting and regulatory (capital buffer and liquidity) constraints. All balances other than loans and deposits are set equal to the opening balance sheet values. It is assumed that all other balances stay static, i.e. do not change over the entire

planning period of one year. Although this is unrealistic, it is done to observe the change in the compositing of the main interest earning liabilities and assets and ultimately the effect of certain changes in important variables on the balance sheet size, profit and balance sheet composition.

The Basel capital implications are mainly implemented in this model. The Liquidity Coverage Ratio (LCR), Net Stable Funding Ratio (NSFR) is not considered. However, liquidity is considered only to a limited extent as indicated above. The final outcome and relationship between assets and liabilities should, however, be very similar to implementing LCR and NSFR.

The data

The final results of ABSA Bank Limited as at 31 December 2012, was used in this research. A simplified balance sheet is used as illustrated below. The only adjustment made to the balance sheet was to split Loans and advances to customers and Deposits due to customers into short-, medium- and long-term line items. The sub-values are fictitious. However, the totals still balance with the original balance sheet. This was done to implement a maturity mismatch constraint as indicated in the previous section under problem formulation. Apart from the balances, the table also indicates the percentages of funds locked up in the different categories of the balance sheet.

Table 3. The data

		Proportion	Opening BS 2012/1/1	Interest rate
Cash, cash balances and balances with central banks		3.217%	24 847 409 691	4.00%
Statutory liquid asset portfolio		4.278%	33 042 731 034	5.00%
Loans and advances to banks		6.038%	46 634 312 485	5.00%
Trading assets		1.744%	13 471 867 777	7.00%
Derivative assets		8.468%	65 406 817 026	7.00%
Total hedging assets		0.406%	3 139 370 276	7.00%
Loans and advances to customers	S	4.165%	32 170 759 269	8.00%
Loans and advances to customers	M	25.893%	200 000 000 000	9.00%
Loans and advances to customers	L	38.839%	300 000 000 000	10.00%
Reinsurance assets		0.117%	902 782 419	0.00%
Other assets		2.187%	16 892 880 183	0.00%
Investments		3.513%	27 132 760 936	0.00%
Subsidiary shares		-0.195%	-1 509 589 231	10.00%
Investments in associated undertakings and joint ventures		0.278%	2 144 009 946	0.00%
Intangible assets		0.124%	957 289 028	0.00%
Property and equipment		0.890%	6 874 905 352	0.00%
Current tax assets		0.008%	59 537 710	0.00%
Deferred tax assets		0.031%	243 055 853	0.00%
Deposits from banks		7.558%	54 928 315 291	3.00%
Trading liabilities		0.654%	4 751 267 937	4.00%
Derivative liabilities		9.355%	67 985 815 297	8.00%
Hedging liabilities		0.149%	1 079 764 107	8.00%
Deposits due to customers - short term	S	11.322%	82 281 091 291	3.00%
Deposits due to customers - medium term	M	13.760%	100 000 000 000	4.00%
Deposits due to customers - long term	L	27.521%	200 000 000 000	5.00%
Debt securities in issue		22.828%	165 899 975 378	0.00%
Normal tax		0.060%	434 157 291	0.00%
Liabilities under investment contracts		1.428%	10 376 919 854	0.00%
Policyholder liabilities under insurance contracts		0.423%	3 076 208 062	7.00%
Borrowed funds		1.692%	12 296 353 503	8.75%
Other liabilities and sundry provisions		1.807%	13 131 045 705	0.00%
Deferred tax liabilities		0.390%	2 834 841 649	0.00%
Share premium - Preference shares		0.639%	4 643 930 718	0.00%
Minority interest		0.143%	1 042 035 781	0.00%
Minority - Barclays		0.270%	1 962 843 519	0.00%
Capital and reserves attributable to equity holders:		6.287%	45 686 334 368	0.00%
Profit		0.000%	0	0.00%
Profit deviation (d1+)		0.000%	0	0.00%
Profit deviation (d1-)		0.000%	0	0.00%
TOTAL		**0**	**0**	

Empirical results

The model was used to illustrate the relationship between the balance sheet size, the profit and risk taking by the bank for different levels of capital. A controversial question is, what should the level of capital be that a particular bank (or all banks generally) should hold as a buffer. Basel prescribes the minima as discussed above. The effect of changing this requirement is addressed in this research. However, the safe level of capital (for a particular bank) is really a function of many things such as the risk policy, current risk profile (Tier 1 and 2 capital and reserves) and the future strategy of the bank within a certain market context. A lengthy discussion of these aspects, fall outside of the scope of this research. However, the point should be made that the level of risk that any bank wants to take on is dependent on its appetite for risk. What any bank therefore views as the optimal capital level is relative and dependant on its strategic goals. This optimal level of capital is not the same as the minimum prescribed by Basel.

The first aspect that is modelled is the impact of change in the capital reserve requirement on the size of the balance sheet. Figure 2 below seems to indicate an exponential decrease in balance sheet size, with the size of the balance sheet falling rapidly at a capital requirement less that 11% and decreasing more gradually thereafter. At a capital reserve requirements of 5%, the resulting balance sheet is 190% of the original balance sheet size, and at the 25% capital reserve requirement the balance sheet is merely 57% of the original size. Increasing the reserve requirement from say 5% to 9,5% gives rise to approximately 40% change in balance sheet size, all other things being constant.

In order to maintain the capital buffer requirement, the model adjusts the size of the balance sheet. The size adjustment is largely due to a decrease in the loans extended to customers on the asset side of the balance sheet and fewer deposits accepted on the equity and liability side of the balance sheet. In order to meet the capital buffer (through the RWA percentages) and different yields on short-, medium and long-term loans, the volumes of these items are adjusted by the model. From the data collected it is evident that banks will have to completely reduce medium and long term loans to R0 in order to meet the capital reserve requirements optimally. Figure 3 illustrates that short-term loans will also be decreased drastically as the reserve requirement increases. These decreases require significant and often costly restructuring within the banking system and could also have a significant impact on the economy if banks withdraw from this market. This is a strategic issue that banks will have to evaluate carefully.

Since banks will not be able to adjust their balance sheets much due to market and internal constraints (even less so over the short term), they will have to find other ways to increase profit. Efficiency, among other things, will probably be one way to improve profit. Instead of focusing on extending the balance sheet and increasing/decreasing the total assets held, banks will have to reduce their assets and function more efficiently if they hope to meet the capital requirements while trying to stay liquid and maintaining an acceptable profitability level for the owners. Another way for banks to increase profitability is to move into new services which bear relatively low risk with a promise of a high payoff. An example would be extended electronic services due to improved technology.

Figure 2. The percentage change in the size of the balance sheet in comparison to the original when a capital reserve is implemented (holding all else static)

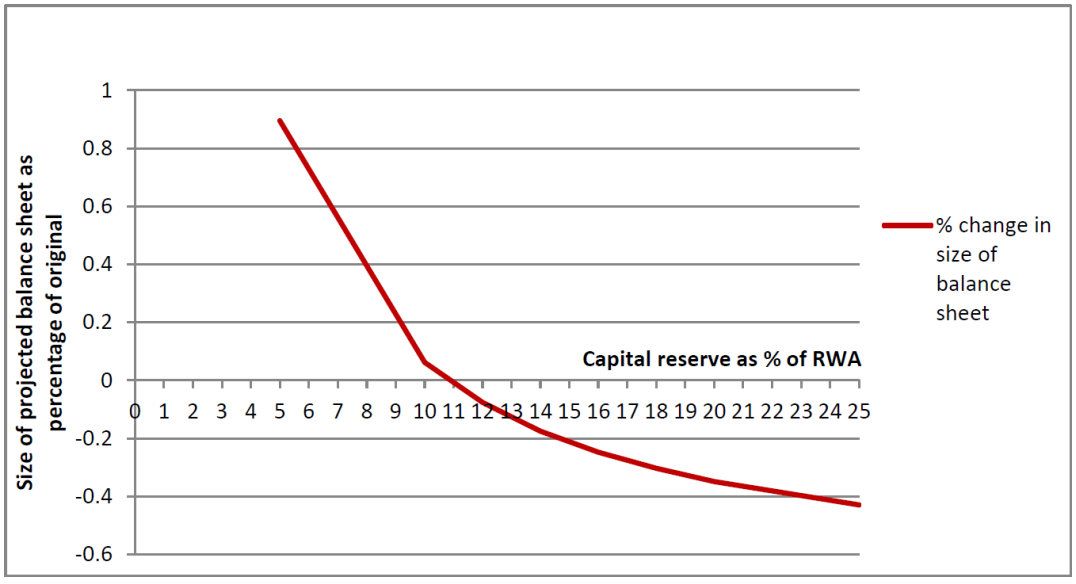
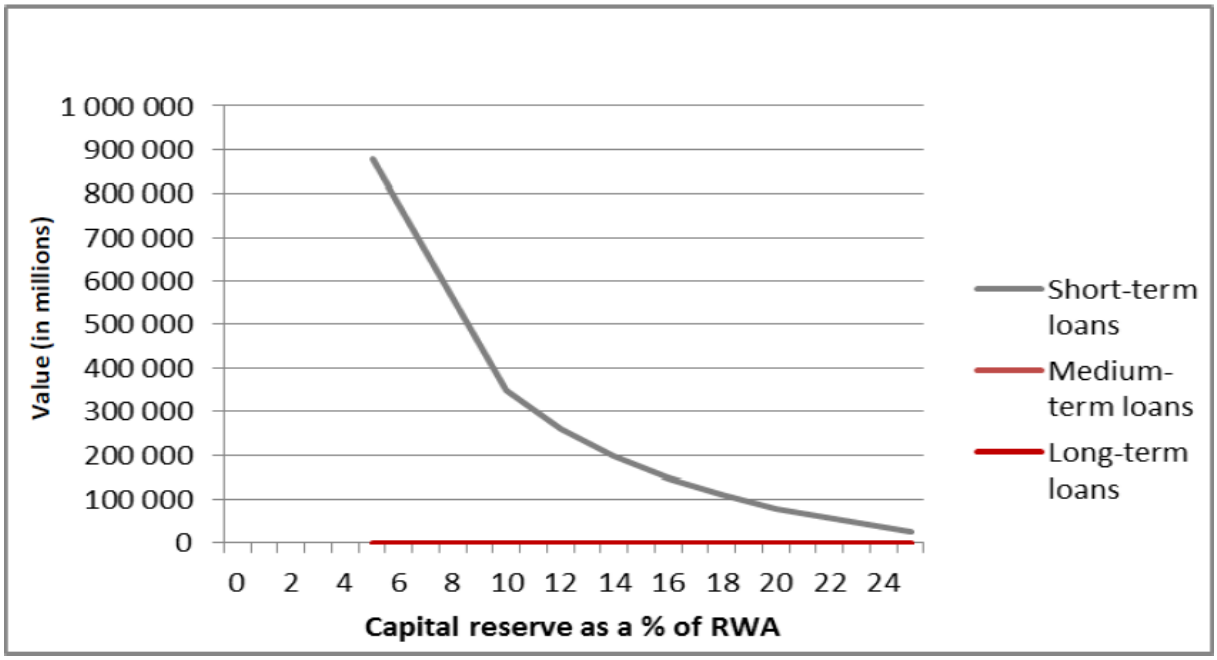


Figure 3. The change in the value of short-term loans as an increased capital reserve requirement is implemented



The next aspect considered is the effect of the capital buffer requirements on the risk weighted assets (see Figure 4 below). Table 2 clearly indicates how the loan balances, which easily make up 70 to 80 percent of the total assets, behave as the reserve requirement is increased. From Table 2 it is evident that the largest constituent of the RWA are short-term loans to customers. These assets have risk-weightings (for this research) ranging between 50% and 100%. From this table it can, therefore, be concluded that banks will have to take on less loans as the capital requirements are increased, assuming that the capital buffer is not be increased in any other way than through profit for the year. If capital increases only by the current year's profit, the reduced higher yielding loans volumes will have a negative impact on profit and ROE. This is demonstrated in Figure 5 below. If the bank wants to maintain the ROE at all cost, it will have to increase the size of the balance sheet (see Figure 2) in order to achieve this target, an option which may turn out to require unrealistic funding. Apart from annual reserve growth, the growth of the balance sheet can only be achieved by a high deposit growth rate or by increasing the borrowed funds.

It may be concluded, tentatively, that, banks may want to invest in riskier assets (as they yield more) as a result of the Basel increased capital requirements due to pressure from shareholders to maintain profitability. Investing in riskier assets requires more capital which can only be acquired through new issue of shares, or reserves earned over time. Alternatively, the balance sheet size has to shrink if no reserves and or capital will be obtained.

In this investigation, the RWA decreased as the capital reserve requirement increased. This was largely due to the shrinking balance sheet and the fact that the reserve value (increased only by the current year's profit of 25%) was kept constant at R57 107 917 960. As in Figure 2, depicting the percentage change in the size of the balance sheet, the value of the RWA also falls exponentially with increasing requirements. If RWA is calculated as a percentage of total assets, however, there is a far more linear relationship between the RWA and the required capital. This can be seen in Figure 4 below.

Figure 4. The change in RWA and the capital reserve held by banks when increased capital reserve requirements are implemented

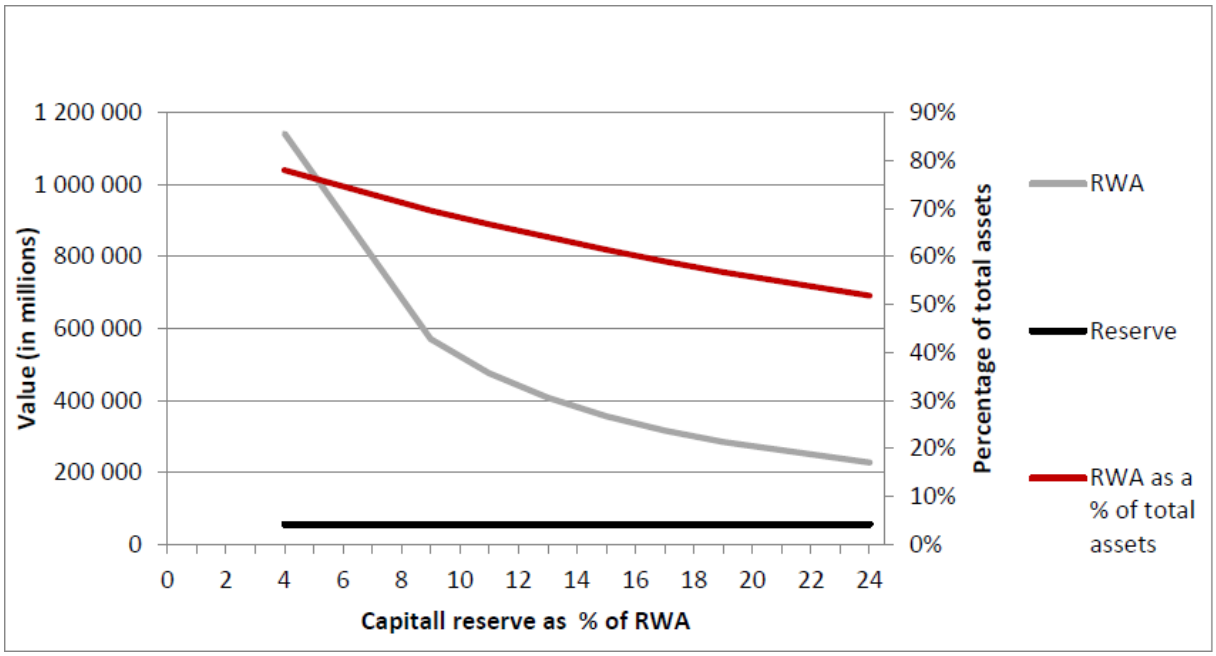


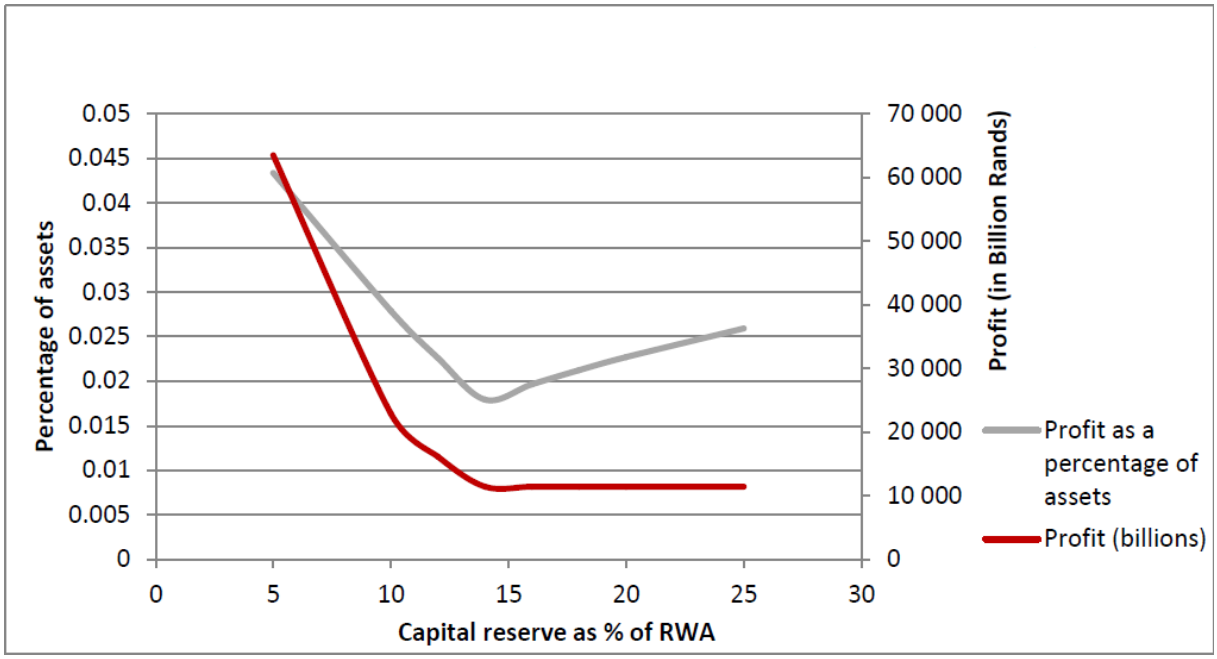
Table 2. The constituents of the total RWA at various capital reserve requirements

	Ret.	5.00%	10.00%	12.00%	14.00%	16.00%	18.00%	20.00%	25.00%
Cash & central bank balances	4%	0.15%	0.16%	0.17%	0.17%	0.18%	0.18%	0.19%	0.20%
Statutory liquid asset portfolio	5%	1.13%	1.20%	1.23%	1.26%	1.28%	1.31%	1.33%	1.39%
Loans and advances to banks	5%	2.93%	3.23%	3.35%	3.47%	3.57%	3.68%	3.78%	4.04%
Trading assets	7%	2.47%	2.30%	2.23%	2.16%	2.08%	2.00%	1.92%	1.71%
Derivative assets	7%	12.34%	11.49%	11.15%	10.81%	10.40%	9.99%	9.58%	8.55%
Total hedging assets	7%	0.27%	0.55%	0.66%	0.77%	0.88%	0.99%	1.10%	1.37%
Loans to customers (short)	8%	76.97%	61.06%	54.69%	48.31%	41.46%	34.60%	27.75%	10.61%
Loans to customers (medium)	9%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Loans to customers (long)	10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Reinsurance assets	0%	1.07%	14.68%	20.12%	25.42%	26.17%	26.91%	27.66%	29.53%
Other assets	0%	0.74%	1.48%	1.77%	2.07%	2.37%	2.66%	2.96%	3.70%
Investments	0%	1.19%	2.38%	2.85%	3.33%	3.80%	4.28%	4.75%	5.94%
Subsidiary shares	10%	0.00%	0.00%	0.00%	0.17%	5.46%	10.75%	16.04%	29.27%
Investments in associates	0%	0.09%	0.19%	0.23%	0.26%	0.30%	0.34%	0.38%	0.47%
Intangible assets	0%	0.04%	0.08%	0.10%	0.12%	0.13%	0.15%	0.17%	0.21%
Property and equipment	0%	0.60%	1.20%	1.44%	1.69%	1.93%	2.17%	2.41%	3.01%
Current tax assets	0%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Deferred tax assets	0%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
RISK WEIGHTED ASSETS		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Profitability is an important aspect to consider. From figure 5 it is evident that the proposed Basel III capital requirements could have a fairly significant impact on the profit level realised in the financial sector. As the capital reserve requirement is increased from 5% of RWA to 14%, the profit falls from over R60 billion to just over R10 billion. At a capital reserve requirement of higher than 14%, the profit level remains constant and a minimum floor level of profit is essentially created.

The drastic decline in the profit invariably arises due to the decrease in the size of the balance sheet with increasing capital stringency. As the balance sheet shrinks, fewer assets are held and, therefore, fewer returns are earned for the bank. This decrease in returns may cause banks to invest in (assumedly) riskier assets in order to increase profitability.

Figure 5. The impact of capital requirements on profit levels



Summary and conclusion

It was explained that as the capital buffer requirements increase, more of the loans balances have to be set aside as capital. In order for the bank to do this, the balances of assets with high risk weightings have to be kept constant to adhere to the capital reserve requirement. The total RWA's are limited by current capital and reserves, which can only increase due to the issuing of additional shares or due to profit realized and carried over to capital and reserves. In these results we see conflicting outcomes. To increase the profit and ROE, the bank has to invest in higher yielding assets which, of course, is more risky and carries higher risk weightings and in the end require more capital and reserves. If the banks want to maintain the ROE at all cost (given an increased CAR), it will have to increase the size of the balance sheet while investing in lower yielding, lower risk assets. If it wants to maintain the ROE but invest in higher risk higher yielding assets, it will have to decrease the balance sheet size. The first alternative may turn out to be unrealistic in the given market conditions. The second alternative may also take time to implement and may be met with resistance.

The question that needs to be answered is: what minimum level of capital should banks maintain? Setting the minimum level of capital as a percentage of RWA's seems to be too a simplistic approach. However, it seems from the observed results that the answer should depend on the risk that an individual bank is willing to take, its current risky position and also on what the market is capable of sustaining, which is very limited in the economy. It also seems as though the banks are caught up between a rock and a hard place. A bank can achieve basically anything as long as it is willing and able to change the input variables. It does seem that the most viable alternative is for banks to focus on being true bankers again and to start focusing on value added services and efficiency.

Many more models can be developed to determine the "optimal" level of capital. However, in the end the answer really has to do with qualitative issues such as bank management in general. Basel III attempts to, among other aspects, set the general level of capital that all banks must maintain now and in future. Is it not really treating the symptoms rather than the problems? The attitude of managers when it comes to taking risk is forgotten – think of the highly geared banks that failed after the financial crisis. Should bank managers not also be held accountable for the way that they deal with funds that belong to other people? Should they not also be prevented from practicing as bankers/bank managers if they are found guilty of unethical practices (including taking undue risk)? Should Basel not also prescribe volumes of investment in certain asset classes or limit risk taking in the first instance? Should certain

product lines such as housing loans not rather be granted by a specialised organization such as SA Home Loans where long term funding can more easily be matched with long term lending?

A lot has been implied above. But, let us not forget how inefficient and unproductive banks can sometimes be. Improving the current business model may go a long way towards increasing or at least maintaining ROE in spite of the Basel III requirements. On the other hand, should shareholder not accept that banks will in future, possibly, have to achieve lower returns?

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