Using Differentiated Approach to Countercyclical Capital Buffer Evaluation
Aleskerov F.T., Kornev A.A., Penikas H.I.

Abstract

Problem of the banking sector cyclicality disturbs regulators at different levels for many years. And no one doubts these cycles have a significant impact on the economy and need to be eliminated. Basel III contributed to this work by preparing a series of recommendations on countercyclical regulation of capital buffer and minimum capital requirements.

In the Basel committee’s standards magnitude of capital requirements is associated with the state of the economy (which is measured by macroeconomic parameters). In particular, it substantiates the usefulness of credit-to-GDP ratio as a common reference point in capital buffer decision process. It is also possible to use GDP growth as a part of composite multiplier which could be used as critical indicator. It was shown by Repullo and Saurina. Unlike the first approach, authors left open the question of critical indicator universality for different countries.

Practical attempts to answer the question above are presented in present paper. By clustering analysis several groups of countries were obtained in order to apply multiplier approach and get the differences. Moreover the estimation intensity parameter included in model proposed by Repullo and Saurina is done.

Keywords: Basel III, Capital buffer, minimum capital requirements, credit-to-GDP

JEL Codes: C38,C61,G20,G21,G28

Introduction

Banking is the most regulated sector in the economy of most countries. As well as economy overall it tends to have cycles and at the same time it is an accelerating force in the process of recovery or recession in non-financial sector. In the time of the credit boom (often with economy as whole or in some sectors - recall "dot-com" crisis) banks are actively expanding their loan portfolios, often do not analyze the creditability of the borrower very well. During this period risks traditionally have been considered low, and provisions for loans are reluctant.

In accordance with the Federal Law about Central Bank, the main objective of bank regulation and supervision is to maintain stability of the banking system and protect
interests of depositors and creditors. In order to achieve these objectives regulator has to intervene in financial cycles in a timely manner. However, not all central banks can manage it, perhaps, due to the fact that the very principles of the bank regulation have pro-cyclical characteristics. The reasons for cyclicality are situated in different spheres such as standards of financial statement, principles of regulation, top management motivation, macroeconomic policy, rating agencies problems, etc.

Faced with the financial crisis 2008, the international community paid a lot of attention to the necessity of moving from pro-cyclical regulatory mechanism to countercyclical [Andrievskaya et al (2010)]. The Basel Committee on Regulation and Supervision of the banking sector has prepared a series of measures that are aimed to address issues of redundancy and capital adequacy. In general, these problems can be solved with the number of following measurements (as they can also be called weaknesses of the regulation).

First, the problem with the reserves during the critical periods for the banks can be solved by switching to a dynamic provisioning [Moiseev (2009)]. This concept involves the creation of reserves not in the period of downturns, but vice versa, during the credit boom, thus it creates a buffer to cover future losses. As a result, it removes the load from the financial result and bank's capital.

Second, in process of determining the factors affecting the capital adequacy ratio, should be analyzed not only the risks of a single bank, but also the macroeconomic risks in general, thus, given the systemic changes in the banking sector, which affect each bank. This could be achieved in practice by calculation of bank capital on the growth of aggregate credit supply, financial leverage of the banking sector or other parameters could be used [BCBS (2010a)].

The third measure [Moiseev (2009)] may be the restriction to the balance sheets blow-up in “credit boom” period on financial or stock market. Capital to not risk-weighed assets ratio will not create an illusion of risk absence in case of economic growth.
Finally, distinction in the regulation of systemically important banks and small market participants will help to divide clearly the responsibility during the credit downturn. There should be taken into account that the systemically important banks are the source of the increased risks for the entire sector, what is why they should apply more stringent requirements.

All these issues imply decline of probability and severity of banking crises. But let us focus on second group of capital regulation measures – defining an optimal macroeconomic parameter (like GDP growth rate, or Credit-to-GDP ratio) [BCBS (2010c), Repullo et al (2011)] which will help in calculation capital requirement for banks.

1. Objectives and goals

The problem of efficient estimating of parameter, that indicates the common reference point for taking buffer decisions, starts from Basel III recommendations concerning capital buffers and minimum capital requirements [BCBS (2010c, 2010a, 2010d)]. The main goal of these recommendations is the protecting banking sector from economic cyclicality. It could be reached by introducing additional variable, which will produce relevant signals about economic cycles and dampen negative effects of cyclicality. The board of committee suggests using the ratio of domestic credits from banking to private sector, to GDP (credits-to-GDP ratio). On the base of this ratio the value of buffer should be calculated following the procedure described in the annex of Basel III Guidance [BCBS (2010c)]. This special capital buffer as intended should reduce excessive cyclicality of bank’s capital – it would be accumulated in credit rise periods, and then be spent in case of recession, when there is a tough need of capital to cover incremental risks.
Basel committee released its Guidance in December 2010 and it was open for a while for feedback done by researchers and nation authorities. In critical assessment, which was prepared by Rafael Repullo and Jess Saurina [Repullo et all (2011)], estimation of counter-cyclical effects of capital buffer is presented. The authors point out that capital buffer act as not intended. To proof these suggestions they estimate correlation coefficient between GDP growth and capital buffer, constructed in line with Basel III Guidance. Negative correlation between capital buffer and GDP growth, and credits-to-GDP gap and GDP growth was received. These results mean that credit-to-GDP gap would tend to signal to reduce capital requirements when GDP growth is high, and to increase capital requirements when GDP growth is low. And it is in direct contradiction of Basel’s III intensions.

Based on their assessment Repullo and Saurina suggest an alternative way to recognizing reference points in order to making capital decisions. Their proposal to tie process of taking capital decisions to GDP growth directly seems more efficient. To speak precisely – is to adjust the point-in-time capital requirements with a multiplier \( \mu \), which is based on GDP growth changing parameter. That formula (6) includes constant, alpha, which stand by sensitivity measure to GDP growth changes.

The main aim of this work is to estimate intensity parameter alpha in order to implement multiplication model proposed by Repullo and Saurina. Moreover hypothesis of country’s clustering according to macroeconomic indicators leads to the appointment of different alpha for different clusters of countries, is tested. In other words, for different clusters of countries, joined by its similar dynamic of macroeconomic indicators (such as: GDP, inflation, unemployment, export and import, and others), the different approach to building minimal capital requirements should be used. It is reached by appointment of different alpha (rate of intensity to GDP growth) to country’s clusters.

This work is organized as follows: section 2 presents an overview of mentioned papers and of models is used. Section 3 is devoted to data description and clustering
process specification. Section 4 expresses our calculations and obtained results. Summary of results and our recommendations conclude present work.

2. Papers and models review

2.1 Basel III Guidance

The process of capital buffer calculating according to Basel III Guidance [BCBS (2010c), pp.12-14] consists of the following three steps:

- Calculation of aggregate private sector credit-to-GDP ratio;
- Calculation of the credit-to-GDP gap (the difference between the ratio and its trend);
- Transforming the credit-to-GDP gap into the guide buffer add-on.

Let’s describe this procedure in details. So, first of all credit-to-GDP ratio for each country should be calculated:

$$ R_i = \frac{C_i}{GDP_i} \quad (1) $$

Then, credit-to-GDP gap is estimating according the next formula:

$$ G_i = R_i - T_i \quad (2) $$

where as a trend a simple moving average or a linear time trend could be used.

Finally, capital buffer is considered by the following rule:

$$ B_i = \begin{cases} 
0; & \text{if} (G_i < L) \\
\frac{G_i - L}{H - L}; & \text{if} (L \leq G_i \leq H) \\
2.5; & \text{if} (G_i > H) 
\end{cases} \quad (3) $$

where $L$ and $H$ – denote a lower and an upper threshold value for the gap. The lower and upper threshold $L$ and $H$ play a key role in determining the timing and the speed of the adjustment of the guide buffer add-on to underlying conditions. BCBS (Basel Committee on Banking Supervision) analysis has found that an adjustment factor based on $L=2$ and
provides a reasonable and robust specification based on historical banking crises [BSBC (2010d)]. However, this depends to some extent on the choice of the smoothing parameter, the length of the relevant credit and GDP data, and exact setting of $L$ and $H$.

In other words, the size of the buffer add-on (in percent of risk-weighted assets) is zero when $G_t$ is below a certain threshold ($L$). It then increases with the $G_t$ until the buffer reaches its maximum level when the gap, exceeds an upper threshold ($H$).

2.2 Impact of new regulatory measures on economics

Speaking about output of new regulatory measures, Basel working paper called “Long-term impact on economic performance and fluctuations” by S. Roger and J. Vilcek [Roger et all (2010)] should be examined. The authors meet the goal to estimate long-term impact of new regulatory capital requirements on economy, mentioned in Basel III guidance. Researchers used DSGE family models (Dynamic Stochastic general equilibrium models) for steady state changes assessment before and after Basel III standards introduction for different scenarios. As a measure of changes the economy output and welfare are taken.

The article presents the following results: 1% of minimum capital requirements increasing entail 0.09% economy output loss. Median effect of new NSFR (net stable funding ratio) is 0.08% in the same way. Moreover, prudential capital requirements tightening leads to output volatility decreasing. There are three major factors, which were considered in this paper. They are: tightening liquidity standards, minimum capital requirements increasing, and stricter quality requirements for capital [Roger et all (2010), pp.9-12]. However the following problems appear. In some models of general equilibrium the banks’ capital or liquidity, or both together are not taken into consideration. Even if the model is sensitive to these parameters, they will are likely not calibrated according to TIER 1 of Basel III.

In details, the authors estimate the effect on long-term steady state through an analysis of long-term indicator of liquidity, using a stochastic model of a general dynamic equilibrium [Roger et all (2010)]. The effect on the deviation of the
resulting performance is evaluated in two ways. The first option (unconditional volatility) involves an analysis of the unconditional standard deviation of key macroeconomic indicators. The second option is to add in macroeconomic model equations for the dynamics of countercyclical capital buffer:

$$v_t = (1 - \rho_v)\bar{v} + (1 - \rho_v)\chi_v X_t + \rho_v v_{t-1}$$  \hspace{1cm} (4)

Where $X_t$ - explanatory variable (also it could be more that one), with $\chi_v$ - sensitivity coefficient to the capital buffer of the explanatory variable. $\bar{v}$ - is a steady state value of capital buffer, and $v_{t-1}$ is a capital buffer in the previous period. All parameters are considered with appropriate weight coefficients $\rho_v$ or $(1 - \rho_v)$.

Impact of new regulatory measures on the welfare is estimated by usage of Van den Heuvel formula for analysis of welfare losses caused by capital requirements tightening:

$$Cost = \frac{D}{C}(R^e - R^d - g_d)\frac{\Delta\bar{v}}{(1 - v)}$$  \hspace{1cm} (5)

Here, $D$ is total deposits (aggregate for the economy’s banking system), $C$ is aggregate consumption, $R^e$ is the risk-adjusted return on equity, $R^d$ is the (average) interest rate on total deposits and $g$ is the share in the non-interest cost, net of any fees, that is attributable to attracting and servicing deposits. This last item can be bound as follows $0 \leq g_d \leq g / D$, where $g$ is operating expenses minus non-interest income (aggregates for the banking system). This leads to an upper bound on $Cost$ (when $g_d = 0$) and a lower bound (when $g_d = g/D$). The key factor in the formula is the spread between the risk-adjusted return to equity and deposits. Intuitively, this reveals the value of liquidity creation by banks, which in turn allows banks to lend at lower rates to firms, to the extent that the spread exceeds the cost of intermediation. Increasing the capital requirement reduces this boost to capital accumulation. The bank debt-to-consumption ratio concerns the importance of bank intermediated finance in the economy.

This long-term assessment paper ends with the following statements:

1. Response to changes in explanatory variables can be considered almost linear – double tightening of regulatory measures leads to a double change in the outcome;
2. Segmentation by region (EU, US, UK...) does not reveal a significant difference in the effect of minimum capital requirements changes;

3. In general for all models - 1% change in capital adequacy ratio leads to average 0.09% loss in the new steady state;

4. Tightening of liquidity requirements (on 25%) leads to an additional output reduction by 0.08% and 50% increase - to 0.15%.

At the end of their work the authors conclude that they got significant values of output variance and welfare changes. 1% changing in liquidity ratios leads to 0.3-2.7% average decrease in output volatility (and with addition tightening minimum capital requirements – decrease of output volatility reaches in average 3.4-10.2% depending on the scenario). Generally speaking, Basel III new regulatory standards imply some losses in output and welfare (in terms of consumption).

2.3 *Alternative approach to defining common reference point*

The article called “The countercyclical capital buffer of Basel III. A critical assessment” written by R. Repullo, J. Saurina [Repullo et all (2011)] is devoted to the problem of capital buffers and minimum capital requirements suggested by Basel III. Authors state that implementation of methodology described in paper implies decrease in capital requirements during the increasing growth of GDP and vice versa. According to Basel III paper the main macroeconomic parameter which influences the size of capital buffer is the credit-to-GDP gap (further CGDP gap). And author consider that this is parameter is the main disadvantage of the methodology. For many countries this parameter is negatively correlated with GDP growth rate. Because of the fact that credits usually linger from business cycle, especially in recession period, detrending procedure slows down capital decision making.

In the paper authors consider the following time series: credit-to-GDP, credit-to-GDP gap, GDP growth and capital buffer (calculated according Basel III) for country set from The World Bank database. As a result they found out that the value of capital buffer
in negatively correlated with CGDP gap. Moreover the correlation strongly depends on sample and time period and choice of common reference point (CGDP or CGDP gap). Basel experts outline that this parameter works good in the case of economic growth but during the recession nations regulator should use additional determinants in order to regulate capital buffer.

Authors investigate whether the credit growth ratio is more efficient than CGDP gap in capital buffer regulation. They made the same correlation calculation procedure using new assumption. As a result they found out that this assumption is correct and credit growth is better systemic risk size signal. It does not create additional constraints for minimum capital requirements and positively corrected with GDP growth rate.

2.4 Computational example

To proof Repullo and Saurina statements we can consider for example Russian macro data from 1993 to 2009 (figures are presented in table 3).

<table>
<thead>
<tr>
<th>Year</th>
<th>C/GDP</th>
<th>trend</th>
<th>gap</th>
<th>buffer</th>
<th>growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>25.92</td>
<td>30.21</td>
<td>-4.29</td>
<td>0.00</td>
<td>-0.05</td>
</tr>
<tr>
<td>1994</td>
<td>31.71</td>
<td>29.95</td>
<td>1.76</td>
<td>0.00</td>
<td>-0.09</td>
</tr>
<tr>
<td>1995</td>
<td>25.46</td>
<td>29.69</td>
<td>-4.23</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>1996</td>
<td>27.84</td>
<td>29.43</td>
<td>-1.59</td>
<td>0.00</td>
<td>-0.01</td>
</tr>
<tr>
<td>1997</td>
<td>29.49</td>
<td>29.17</td>
<td>0.32</td>
<td>0.00</td>
<td>0.03</td>
</tr>
<tr>
<td>1998</td>
<td>44.93</td>
<td>28.91</td>
<td>16.02</td>
<td>2.50</td>
<td>-0.33</td>
</tr>
<tr>
<td>1999</td>
<td>33.33</td>
<td>28.65</td>
<td>4.69</td>
<td>0.84</td>
<td>-0.28</td>
</tr>
<tr>
<td>2000</td>
<td>24.71</td>
<td>28.39</td>
<td>-3.67</td>
<td>0.00</td>
<td>0.33</td>
</tr>
<tr>
<td>2001</td>
<td>25.56</td>
<td>28.13</td>
<td>-2.57</td>
<td>0.00</td>
<td>0.18</td>
</tr>
<tr>
<td>2002</td>
<td>26.80</td>
<td>27.87</td>
<td>-1.06</td>
<td>0.00</td>
<td>0.13</td>
</tr>
<tr>
<td>2003</td>
<td>27.81</td>
<td>27.61</td>
<td>0.20</td>
<td>0.00</td>
<td>0.25</td>
</tr>
<tr>
<td>2004</td>
<td>25.65</td>
<td>27.35</td>
<td>-1.69</td>
<td>0.00</td>
<td>0.37</td>
</tr>
<tr>
<td>2005</td>
<td>22.09</td>
<td>27.09</td>
<td>-5.00</td>
<td>0.00</td>
<td>0.29</td>
</tr>
<tr>
<td>2006</td>
<td>22.44</td>
<td>26.83</td>
<td>-4.39</td>
<td>0.00</td>
<td>0.30</td>
</tr>
<tr>
<td>2007</td>
<td>25.47</td>
<td>26.57</td>
<td>-1.10</td>
<td>0.00</td>
<td>0.31</td>
</tr>
<tr>
<td>2008</td>
<td>25.11</td>
<td>26.31</td>
<td>-1.20</td>
<td>0.00</td>
<td>0.28</td>
</tr>
<tr>
<td>2009</td>
<td>33.85</td>
<td>26.05</td>
<td>7.80</td>
<td>1.81</td>
<td>-0.26</td>
</tr>
</tbody>
</table>

Source: World Development Indicators Database and own calculations according to the standard
Based on this data correlation coefficients were estimated (All coefficients are significant on 99% confidence level (table 2).

<table>
<thead>
<tr>
<th></th>
<th>gap</th>
<th>buffer</th>
<th>growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>gap</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>buffer</td>
<td>0.92</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>growth</td>
<td>-0.73</td>
<td>-0.72</td>
<td>1</td>
</tr>
</tbody>
</table>

So, Repullo and Saurina were right. These calculations also proof the fact that present capital buffer regulation contributes increasing of buffer in case of recession and decrease of buffer during the “credit boom”. But Basel experts expected the opposite effect.

Also assessment’s authors pay attention to procyclical character of minimum capital requirements. In Basel III approach based on calculation probability of default in one year time horizon is presented. Using of this approach leads to excessive volatility of minimum capital requirements during the economic cycle (probability of default is estimated by considering such factor as borrower’s characteristics, credit features and characteristics of macroeconomic situation).

Instead of smoothing output data the authors suggest to implement the risk sensitivity to the model to input data. It means that minimum capital requirements will be corrected with multiplier (6) described further. It is worth to mention that multiplier was not estimated in their paper, so it is still an open question. Present work is a one of the solution of that problem.

According to Repullo and Saurina multiplier $\mu$, is defined as follows:

$$\mu(t) = 2N\left(\frac{\alpha(g_t - g)}{\sigma_g}\right)$$

(6)
where $g_t$ is the rate of GDP growth, $\bar{g}$ is long-term average, $\sigma_g$ is long-term standard deviation, $N(.)$ is the standard normal cumulative distribution function (the choice of normal distributional function is quite reasonable, because we deal with normalized and detrended GDP growth rate and there is no need to consider more complex distributional functions), and $\alpha$ is positive parameter to be estimated (in their paper [Repullo et al (2011)] the authors did not solve the optimization problem). The multiplier $\mu_t$ is continuous and increasing in $g_t$, so capital requirements would be increased in credit rise periods and reduced in recession periods. The multiplier $\mu_t$ is equal to 1 when $g_t = \bar{g}$, so there be no adjustments at the midpoint of the business cycle, and it is bounded between 0 and 2, so capital requirements would not increase without bound or become negative. The normalization by $\sigma_g$ allows to express capital surcharges or reductions per standard deviation of GDP growth.

3. **Data processing**

The method of cluster analysis has been used to construct a classification of countries based on key economic indicators. This method allows combining "similar" objects (in terms of selected measures) in separate homogeneous groups.

Key economic indicators characterizing the economy were highlighted and the resulting list includes the following indicators:

- Unemployment as a percentage of total workforce
- GDP in U.S. dollars
- GDP per capita in U.S. dollars
- Inflation rate (calculated on consumer prices), percent per annum
- Exports of goods and services as a percentage of GDP

3.1 **Data description**

Data for the analysis come from an annual panel survey done by the World Bank (World Development Indicators Database). The sample consists of 67 countries and includes all leading countries. Database covers the period from 1998 to 2007. The
sample includes all countries for which data exist in the database for all indicators and for at least 9 year during the whole period of observation.

Descriptive statistics and correlation coefficients for the indicators used are presented below (tables 3 and 4):

Table 3. Summary of statistics

<table>
<thead>
<tr>
<th>Descriptive statistics</th>
<th>Unempl. (%)</th>
<th>GDP (bill.$)</th>
<th>GDP per cap.($)</th>
<th>Infl.(%)</th>
<th>Exp.(%GDP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>min.</td>
<td>1</td>
<td>0.6</td>
<td>321</td>
<td>-4.0</td>
<td>6.9</td>
</tr>
<tr>
<td>max.</td>
<td>37.3</td>
<td>14061</td>
<td>106831</td>
<td>297.6</td>
<td>208.0</td>
</tr>
<tr>
<td>mean</td>
<td>8.7</td>
<td>540</td>
<td>15496</td>
<td>6.6</td>
<td>46.8</td>
</tr>
<tr>
<td>stand. Dev.</td>
<td>5.6</td>
<td>1514</td>
<td>15954</td>
<td>16.1</td>
<td>29.0</td>
</tr>
</tbody>
</table>

Table 4. Correlation between parameters

<table>
<thead>
<tr>
<th>Correlation coeff.</th>
<th>Unempl.</th>
<th>GDP</th>
<th>GDP per cap.</th>
<th>Infl.</th>
<th>Exp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unempl.</td>
<td>1</td>
<td>-0.14</td>
<td>-0.39</td>
<td>-0.03</td>
<td>-0.20</td>
</tr>
<tr>
<td>GDP</td>
<td>1</td>
<td>0.28</td>
<td>-0.08</td>
<td>-0.25</td>
<td></td>
</tr>
<tr>
<td>GDP per cap.</td>
<td>1</td>
<td>-0.22</td>
<td>0.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infl.</td>
<td>1</td>
<td>-0.04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exp.</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thus it may be noted that the study covers a wide range of countries (GDP of which varies from 0.6 to 14 061 bill. $; the dispersion of other indicators is rather quite high), representing very different economy.

Overall, the data agreed with expectations. A negative correlation between the size of the economy (GDP) and the number of unemployed people is highlighted. Indeed, the larger the economy is, the more workplaces it could propose for people. The same logic could be applied to the negative relation between unemployment and export.

3.2 Methodology
The values of each indicator were independently normalized for all observations as follows (7):

- For each indicator were identified maximum and minimum values, these values in the new scale were equal to 10 and 0, respectively,
- All other values were displayed in the interval from minimum to maximum in the interval from 0 to 10 with preservation of the relationship of distances to the endpoints.

$$X_{scaled} = \frac{X - X_{min}}{(X_{max} - X_{min})/10}$$

(7)

where $X$ is a parameter value, $X_{min}$ and $X_{max}$ its minimum and maximum for all countries and periods.

The number of clusters has been set to 15 for applying the procedure of K-means. The distribution of observations across clusters has presented in the table 5 below.

<table>
<thead>
<tr>
<th>Cluster #</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of observation</td>
<td>14,8%</td>
<td>7,5%</td>
<td>2,9%</td>
<td>0,3%</td>
<td>2,0%</td>
<td>8,6%</td>
<td>3,2%</td>
<td>13,4%</td>
</tr>
<tr>
<td>Cluster #</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Share of observation</td>
<td>2,9%</td>
<td>5,0%</td>
<td>16,4%</td>
<td>11,3%</td>
<td>1,5%</td>
<td>2,3%</td>
<td>8,0%</td>
<td></td>
</tr>
</tbody>
</table>

Hence, small clusters are skipped. The description of significant clusters (#1, #8, #11 that contain more than 12% of observation) below is based on key economic indicators.

Each country changes the cluster 1.36 times (on average) during the period of observation (figure 1). Changing the cluster can be associated with the phases of the business cycle in countries (Argentina, 2005), with economic development, e.g. GDP growth or with changes in government policy objectives (low level of unemployment/GDP per capita growth).
Calibrating is prepared for all significant clusters (cluster #1, cluster #8 and cluster #11, which were performed as was describe in previous section) for countries with full time series of observations of economic indicators (where growth and credit-to-GDP series from 1998 to 2007 year are completely presented in the same cluster). It was done in order to get as long as possible continuous time series within one cluster. At the same time, countries in every cluster have been divided on the training and testing set. Multiplier model was firstly estimated using data from training set. After that, alpha constant, which was obtained from first step, was applied for the same model but for the test part of countries within the same cluster. It was done to check the significance of clustering and estimation. Division of countries with in the cluster is presented in table 6:
<table>
<thead>
<tr>
<th>Indonesia</th>
<th>Estonia</th>
<th>Finland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peru</td>
<td>Hungary</td>
<td>France</td>
</tr>
<tr>
<td>Romania</td>
<td>Maritius</td>
<td>Germany</td>
</tr>
<tr>
<td>Russia</td>
<td>Moldova</td>
<td>Israel</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>Slovenia</td>
<td>Italy</td>
</tr>
<tr>
<td>Turkey</td>
<td></td>
<td>Japan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UK</td>
</tr>
</tbody>
</table>

We used here our common assumption that the coefficient alpha should be the same for all countries within the same cluster. That is why the separation of the training set and the testing set within one cluster is performed randomly. In the future it is possible to test the impact of various groupings of countries into training and testing sets. However, this task is beyond the scope of this article.

4.1 Formulation of objectives

In order to estimate alpha, used in multiplier model, the criteria of optimal value should be defined. We took two simple assumptions: 1) minimum capital requirements should decrease in case of recession (low rate of GDP growth) and increase when the economics conditions become better; 2) minimum capital requirements should increase when the credit demand rises, and vice versa. That is why dynamic of multiplier should replicate the behavior of GDP growth rate, and at the same time it should behave the opposite way with respect to credit-to-GDP rate dynamic. The similarity in the dynamics of parameters can be estimated by calculating the correlation coefficient between these two time series. In our case, the first correlation coefficient should be maximized, and at the same time the second correlation coefficient should be minimized.

It is worth to mention that solving this problem by using only one factor (only by maximization of the first correlation coefficient or by minimization of the second
correlation coefficient only), will not lead to the desired result. It has been tested in practice. Initially, when the criterion of the optimal value of the parameter alpha was the maximum of correlation between multiplier and GDP growth time series, the calculations did not converge to the optimal value (see figure 1). Due to the fact that the correlation coefficient takes its maximum value when the vector is composed of the same values (corresponding to alpha value is equal to 0). So, second additional criterion is needed to restrict the bottom value of alpha parameter.

Figure 2.
Correlation criteria

Now, recall the fact that Repullo and Saurina observed in their work. They identified the negative correlation between credit-to-GDP ratio and capital buffer and between credit-to-GDP ratio and GDP growth. Calculations, made in this paper, confirm this statement and, moreover, reveal the presence of negative correlation between credit-to-GDP ratio and multiplier time series. The last agrees quite well with the theoretical suggestion [Repullo et al (2011), p.4] that the credit-to-GDP ratio, to some extent, is an estimate of demand for capital imposed on the banking sector by the economy. The higher the value of credit-to-GDP ratio is, the more capital is needed to economy (in case of simultaneous growth GDP) and finally the less volume of capital requirements should be determined.
Another important fact is that the dynamics of the indicators are not synchronized. The credit usually lags the business cycle, especially in downturns. However, the study of this issue is also beyond the scope of present paper.

4.2 Criterion of optimality

Taking into consideration all the observations concerning relationship between mentioned parameters, correlation criterion, which consists of two correlation coefficients could be produced (linearity is assumed because of better empirical convergence). The following simple criterion meets our requirements:

\[ Corr.Crit. = (cor_1 + |1 - cor_2|) \]  

where \( cor_1 \) - is a correlation coefficient between multiplier \( \mu \) and growth rate, and \( cor_2 \) - between multiplier \( \mu \) and credit-to-GDP rate. First correlation coefficient ranges from 0 to 1, second - from -1 to 0, and we must derive their superposition (which ranges from 0 to 2) to the maximum.

Since the maximized value is a function of the normal distribution cumulative function, the solution of this problem theoretically represents a significant challenge. Therefore we decided to use an iterative estimation method. Direct optimization was performed in Matlab environment. As a matter of fact, due to Matlab specifics\(^1\) not the maximization of mentioned criterion (5) was performed, but minimization of modified correlation criteria (6).

\[ Corr.Crit. = 1/(cor_1 + |1 - cor_2|) \]  

It is easy to see that the proposed actions are equivalent. Results of alpha modeling (including the detailed graph description) are presented below.

\(^1\)Internal Matlab function fminbnd(name, a, b [, options]) was used. It finds the function *name* minimum at given interval [a,b]. Written function which was inserted in fminbnd counts the correlation criteria (6).
Table 7.
Alpha overview within clusters

<table>
<thead>
<tr>
<th>Alpha</th>
<th>Training Set</th>
<th>Testing Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>cluster 1</td>
<td>2.68</td>
<td>3.11</td>
</tr>
<tr>
<td>cluster 8</td>
<td>5.55</td>
<td>5.45</td>
</tr>
<tr>
<td>cluster 11</td>
<td>0.85</td>
<td>0.27</td>
</tr>
</tbody>
</table>

On the next series of graphs presented here, interdependence between correlation criterion (‘C/c’ – on the ordinate) and the parameter alpha (‘alpha’ – on the abscissa) for every cluster and every subset is shown.

For cluster 1 (training set) $\alpha = 2.68$:

From the graph we see that the criterion achieve its minimum when the parameter alpha is 2.68. Moreover, at the point 2.68 global minimum of correlation criteria is reached. This was verified by analyzing correlation criterion at different intervals. Finally, a rather wide range from 0 to 10 was represented on the chart in order to emphasize the stability of the global minimum.

It is worth to mention that, after reaching its minimum criterion begins long steady growth, tending to its maximum. In comparison with similar figures constructed for other clusters, we can emphasize the high sensitivity of correlation criterion to changes in the parameter alpha.
Now turn to the question of the relationship between the criterion obtained for the training sample and testing sample. We got two criterion values 2.68 and 3.11 which are rather close to each other. In order to improve of this work, we suppose to test the significance of difference of these variables. However, these tests were not conducted in present work.

Conclusion that two alpha values are similar is based on the fact that their difference within one cluster is much smaller than the alpha values difference between different clusters. In other words, internal alpha variance is much lower than external.

So, all above statements allow to make a conclusion that difference in alpha values between clusters is significant, but within the same cluster difference is not significant!

For cluster 8 (training set) $\alpha = 5.55$ :  

![Graph for cluster 8 (training set) $\alpha = 5.55$.](image1)

For cluster 8 (testing set) $\alpha = 5.45$ :  

![Graph for cluster 8 (testing set) $\alpha = 5.45$.](image2)

Correlation criteria function in the neighborhood of the optimal point is characterized by a lower sensitivity to parameter alpha change. With increasing alpha parameter correlation coefficient decreases significantly. Decline slowing occurs only at the point where alpha is around 4. After reaching its minimum correlation coefficient starts to increase, showing as was mentioned, low sensitivity to alpha changes.

Alpha values obtained from training and testing subsets differ by a smaller amount than it was in cluster #1. And it is a good sign which signals about well
performed clustering. Optimal alpha form cluster #8 is twice larger than alpha from cluster #1, which corresponds to greater multiplier sensitivity to GDP growth changes. Graphs from Appendix 3 also presented parameter’s relation within particular cluster.

For cluster 11 (training set) $\alpha = 0.85$:

For cluster 11 (training set) $\alpha = 0.27$:

Unlike concerned criterion functions of cluster #1 and cluster #8, there is no left tail because optimal alpha value is closer to 0 than others, which corresponds to low sensitivity to GDP growth changes. Optimal alpha value is also quite stable.

**Conclusion**

This work shows that there is a significant difference between alpha values for various clusters. It leads to denial of unified approach of minimum capital requirements definition. And this is the point that should be taken into consideration by BCBS.

Multiplier intensity to GDP growth and credit-to-GDP changes for countries from cluster 8 is twice than this parameter for countries from cluster 1, and 6 times higher than the same parameter for countries from cluster 11 [Annex 2]. In other words, countries which belong to the first cluster are subject to greater volatility of GDP growth, and as a consequence, greater volatility in minimum capital requirements and buffer.

In general, the use of dynamic capital buffer regulation approach reduces the vulnerability of the banking sector in times of recession [Roger et all (2010)]. What is why further study the factor, which influence buffer decision making process, should be continued.
### Annex 1

**FEATURES OF MAJOR CLUSTERS**

<table>
<thead>
<tr>
<th>Cluster #</th>
<th>Some member countries</th>
<th>Average statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Argentina (2005-2007), Brazil, Egypt, Hungary, Greece (1998-2003), Indonesia (except 1998), Peru, Romania, Russian Federation (2001-2005), Turkey</td>
<td>Unemployment % of GDP 9.0</td>
</tr>
<tr>
<td>8</td>
<td>Czech Republic (1998-2006), Estonia (except 1999-2001), Moldova (2000-2007), Slovenia, Ukraine (2003-2007)</td>
<td>Unemployment % of GDP 7.3</td>
</tr>
<tr>
<td>11</td>
<td>Australia, Canada (1998-2006), France, Germany, Italy, Israel (except 2002-2004), Japan, Spain (2003-2007), UK</td>
<td>Unemployment % of GDP 7.5</td>
</tr>
</tbody>
</table>
Annex 2

MUTUAL DYNAMICS OF MACROECONOMIC PARAMETERS

Here starts next series of graphs, which denote relations between all concerned time series – GDP growth, multiplier and credit-to-GDP series. At the abscissa time periods are marked.

Figure 1.

Relations between macroeconomic parameters for countries from cluster 1
(where alpha is 2.68)

Multiplier is well synchronized with GDP growth. In case of GDP growth decline multiplier decreases at the same time period.

Figure 2.

Relations between macroeconomic parameters for countries from cluster 8
(where alpha is 5.55)
While credit-to-GDP ratio behaves asynchronously with respect to GDP growth rate, multiplier replicates every movement of GDP growth time series and reacts immediately at the same time period. But with respect to credit-to-GDP ratio multiplier shows some lags. And this fact suits the theory of interaction of demand and supply of capital.

It is easy to see that multiplier in cluster #11 has smaller variance than in cluster #1 or cluster #8, so the same could be attributed to GDP growth behave.
REFERENCES


