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EFFECTS OF SCORING SYSTEMS TO THE RESULTS OF
ECONOMIC CAPITAL MODELS IN THE INSTITUTIONAL
CAPITAL CALCULATION

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1. HISTORY AND OBJECTIVES OF THE RESEARCH

The recommendations of Basel II laid out in 2004 contained a number of new approaches to define the foundations of a safer banking system. One of these new elements was that it allowed the financial institutions meeting a predefined set of minimum requirements to calculate their own minimum credit risk requirement, knowing their own portfolio the best. As capital is the main loss absorption buffer of a financial institution, these calculations have a very large effect on how a bank can withstand shocks in a crisis situation and how it will be dependent on external help to avoid bankruptcy (or get into a liquidation proceeding eventually).

The regulator declared on a high level that such a minimum capital requirement shall be held where the institutions can withstand economic shocks at 99.9% of all cases without external help, using their own funds and sources only. In my dissertation I show that the minimum requirements set out by the regulator do not ensure that institutions following these minimum requirements will need external help only 1 case out of 1000 economic shocks. The result of these minimum requirements resulted also that in the latest crisis institutions had a generally low level of capital available, the calculated minimum capital requirement was generally low, institutions needed external saving plans in Europe and a bank default wave could be observed in the United States. This points to a general conceptual problem of utilized methods that are not addressed by the current regulation, these problems are analysed and answers are searched throughout the dissertation.

During my work experience I observed that was also strengthened by the European level measures of financial sector saving programs that the current system cannot meet fully with its declared goal. At the start of my research Basel III was not even a plan, however, this framework published lately tries to find some answers addressing the question how to ensure stability of a financial system from within the system.

I set out as a main objective of my dissertation that using the logic of the current industry standard advanced credit risk management methods (as scoring system development, PD estimation and economic capital calculation), satisfying all regulatory minimum requirements the resulting situation within the financial institution will be procyclical. The better the current risk estimation methodologies are, the stronger this effect will be

resulting in a capital requirement that will fluctuate along with the economy. The stability that is required by the regulator can be met, however, this will not necessarily mean that the current system would be procyclical that will be finally result in external financial rescue operations on an international level.

The dissertation analysed two hypothesis in detail:

1. The forecasting power of scoring systems change significantly in economic crisis situations.
2. The PD forecasted by scoring systems change significantly in crisis periods (through which provision and capital levels are affected)

My objective was in general to show that by following regulatory requirements, a stable and precise corporate rating system can be developed that seemingly might be most appropriate to base a long-term PD estimation on its results.

My expectations were that the first hypothesis can be rejected, that is, following an industry standard scorecard building process, a stable and robust rating model can be set up. The techniques and methodologies shown in the dissertation a crisis-proof rating system can be developed.

During the analysis of my second hypothesis I show that doing everything according to regulatory minimum requirement, a PD estimation logic will provide a portfolio-level PD estimation where PD levels will significantly change over a crisis wave. As the Basel II requirements are not totally prescriptive, it is not impossible to create a portfolio-level stable PD estimation method, but following the regulatory needs it is most likely that the final PD level will be a PD that goes along cyclical movements. MY expectation were that my second hypothesis can be accepted.

Generally, the current regulatory structure defines contradictory minimum requirements for rating system development and portfolio models. This originates from the difference in the goals of these two areas, the scoring systems are developed to capture the exact and precise credit risk level of an asset, that is the portfolio has to be re-rated as frequently as possible, the economical capital models aim to set a long-term stable portfolio level PD that will be the same in and out of crisis. The regulatory minimum requirements need the re-rating of the portfolio on a minimum one-year frequency and the same applies for the adjustment and correction of PD estimations. Institutions are required to rate the clients into rating categories that provide a risk level differentiation and that have a long-term estimation of risk parameters (PD and LGD). Capital requirement resulting from these minimum requirements will be rather cyclical, because the migration within risk categories are not limited, therefore in a crisis situation the portfolio can

migrate over the complete rating scale. The capital calculation framework defined by the regulator does not handle appropriately cyclical input data, resulting in a strongly procyclical capital level: in crisis period estimated PD levels can increase strongly because of portfolio migration and PD recalibration.

My dissertation shows all aspects of the problem through an openly available corporate portfolio. A rating system development is performed, and I demonstrate that having a long-term stable rating system can cause a cyclical movement in the PD level, provisioning and capital. I will show how the Basel III framework tries to address this problem and I will also analyse how it is a surface treatment and not a real solution. At the end I will make proposals how to handle the problem at its root cause, addressing better the problem itself.

2. MATERIAL AND METHODOLOGY

In the dissertation I demonstrate using a corporate sample portfolio the credit risk issue that causes the cyclicity problem. I present the different effects that will affect the final results through the scoring development and PD estimation process. This requires conducting a complete rating system development and calibration process.

I describe the basic information and characteristics of the sample portfolio. For the analysis I use local financial statement information and local bankruptcy and liquidation data from public sources. Based on the available data I create the parameters of a risk assessment (rating) system and assess a hypothetical random portfolio of these clients according to regulatory requirements – at a minimum frequency of one year. The complete portfolio is reassessed like in a normal institutional workflow. Based on the regulatory requirement a risk parameter calculation model is created and PD is calculated whereas other risk parameters (LGD and EAD) is disregarded, assumed having a fixed value during the analysis. This is required because although the current financial crisis have shown that LGD values might change significantly in crisis periods, public information are completely unavailable on this field. This is why the dissertation focuses on the analysis of the PD risk parameter. EAD is quite stable compared to other risk parameters, the drawn amount at default is quite high in and out of crisis situations and there is no much room for worsening in bad times. I assume a normal on-balance loan exposure in the analysis, not a limit-like exposure that can be affected by the EAD (because the client can access additional exposure before going bankrupt), therefore the calculation of EAD can be ignored. The amount of loans are not shown in the analysis, percentages are calculated to show the relative effects and present the result of the analysis.

At the end I calculate also the required capital levels using a simple reduced form portfolio model (ASRF portfolio model), and I present that although that I considered all relevant regulatory prescriptions, and arrived to a stable model, the final capital level is cyclical. I do not calculate with a structural portfolio model, because although the rating migrations could be calculated from the data, the calculation of such models are also dependant on the discounted value of loans (that depends on the risk rates and yield curves that can be unstable), that would bring another form of assumptions to the analysis. Choice of the capital calculation methodology does not have a significant effect on the results of the calculation.

To illustrate the logic of the calculation an in-depth methodological analysis is required that is presented in the dissertation. I present the model framework that has been applied in detail as well as the risk parameter estimation logic and capital calculation approach. I describe all choices but detail only the relevant approaches that were used to arrive at the final results. I also detail the rationale behind choosing one or another approach when there are more options to be chosen from. I utilize the best industry solutions I met during my work that – as I will show it – are fully compliant with regulatory requirements.

3. RESULTS

During the analysis a well-performing rating system has been developed with which the complete available time series was rated. As a result, the stability of the results, the discriminatory power of the developed rating system and the validity of my first hypothesis could be assessed.

Following this analysis a PD model has been developed that performed a long-term PD calibration according to regulatory requirements, and the final movements in PD could be observed. The swings in the level of PD can be seen, and the validity of my second hypothesis could be addressed.

The final results were shown in terms of capital, assuming the possible movements when using a behavioural model.

The rating system that has been developed can be regarded as an application scoring system, as unfortunately there are no public sources for behavioural analysis. The effect that was to be observed can be assessed partially, but I also stated where – according to my work on non-public data – the effects can be observed stronger.

According to the detailed analysis presented in the dissertation it can be stated that although the default rates over a longer period can be varying greatly, showing upswings in crisis periods, utilizing the industry best

practice methodologies of scoring development in an appropriate way, a stable and strong rating system can be developed that doesn't need to be changed over a years. Main steps of these practices were shown in the dissertation that are the followings:

- Appropriate variable selection: the single factor analysis shall include a time stability analysis. A powerful variable can have great GINI, but unstable variables perform poorly in crisis periods. Such variables need to be selected in a rating system that
 - o have high standalone discriminatory power
 - o loose only a fraction of their power in crisis
 - o their categorization does not change significantly or show concentration in a crisis period
- Appropriate variable transformation: to squeeze the last bit of information out of a single factor, the Weight-of-Evidence transformation is a very helpful tool. It handles extreme values and non-linear dependencies that are very common in corporate rating development.
- Exact correlation analysis: it shall be considered during the development that non-correlating variables are the best for the industry standard logistic regression, the final model shall be built mostly on non-correlating single factors.

As a final result I can declare that – along with my initial conjecture – **I can reject my first hypothesis**, since there is a methodology for an institution to develop stable and durable rating system, and as a consequence, a rating can be implemented that does not require frequent redevelopment.

A boundary condition for this is that an institution shall have data for a longer time period, if possible, have information spanning over an economic cycle and having variables that perform stable over these period. If the institution does not collect such information or the data collection logic or quality changes over time, then the institution might experience difficulties in developing a stable a durable rating system.

According to my results, my second hypothesis is valid, as according to the regulatory requirements the most exact and accurate, the most recent risk assessment shall be used that result in the frequent reassessment of client risk. Especially in the field of retail loans it can be observed that institution using behavioural scoring can reassess the complete portfolio for each month that can follow next year's PD very precisely, that are also checked by the internal validation teams of these institutions. These banks will follow the waves in the default rate connected to an economic cycle when calculating the portfolio-level PD value. This effect can also be observed in a dampened

way in the calculation of the capital requirement, making it procyclical, resulting in a higher minimum capital requirement at crisis periods and lower capital minimum in economic upswings than the long-term average PD value of the total bank portfolio.

I can confirm my second hypothesis. My calculation show a 20% change in capital minimum considering the complete local corporate segment, if the institution utilize a rating model capturing the default rate exactly (e.g. considering due days during rating assignment). I assess this as a significant effect.

4. CONCLUSIONS

Concluding my dissertation, my analyses show that there is a possibility to create a crisis-proof, stable rating system, the rating logic itself if developed properly does not cause cyclicity or movements in the capital requirement. Utilizing the best practices of rating development I have shown in my dissertation stable and solid rating models can be created that perform well over economic cycles.

However, it can be also concluded that the current regulation contains several elements regulating rating systems that affect the capital requirement of the institution. There requirements define that a rating system an institution can use in its capital calculation shall be exact, actualized, predictive and stable. The problem is, that these properties cannot be fulfilled all at once. Either we have to give up stability over time or we have to waive the need for exact and predictive rating and create a rating according to these properties.

Even if a very good quality and well performing rating system is produced that has stable discriminatory power over time, which quantifies a through the cycle PD for all rating categories, the migration of the portfolio over the rating scale and the composition effect it causes can elevate PD massively during crisis, causing procyclicality. Because a rating system developed by an advanced financial institution can have high discriminatory power, the PD range it can capture can also be high, and as a result, capital requirement can fluctuate over a broad range.

My conclusion is that a stable through the cycle PD can be quantified by a rating system that can calculate similar risk assessment for a given client over time, being a corporate or a retail customer, and changes in time shall move the risk assessment of the client in a limited way. If the financial institution creates a rating system that react sensitively to changes in risk, the change will be instantaneously alter the long term PD estimation. As the portfolio composition changes, and clients migrate up and down on the rating scale, the final calculated capital charge will be unstable.

5. NEW SCIENTIFIC RESULTS

In my dissertation I showed what the cause is that in crisis institutions meet severe shortage in capital, although they have very well working credit risk models. The answer to the question is clear, based on data it can be shown that the current regulatory regime is contradicting, the regular re-rating logic is inconsistent with the requirement that institutions shall calculate a minimum capital requirement that is stable and provides coverage for credit risks over economic cycles. I showed that this procyclical effect was detected by the regulators but not the most appropriate answers were provided to solve this problem. The current proposal is to define an anticyclical capital buffer on a systemic level, which is a rough and in certain portfolios insufficient, at other cases exaggerated solution for the problem. This solution does not cope with the effect even in that case if the regulators will know exactly if the current economy is in upswing or in crisis.

Based on my analysis I proposed two methodologies to treat this effect to get the current regulatory requirements and the methodological framework closer. My first proposition is to detach rating systems completely within the IRB method so that risk assessment will be based on calculating the long term default rate and loss rate for a predefined, fine segmented portfolio according to regulatory definition, without the use of rating-like variable or delinquency. As a result of this, a quite stable and long-term capital minimum requirement can be set, and rating systems will be given back fully in institutional control, to manage internal processes, as before Basel II. My second proposal is also refuses to use a buffer like solution. It requires that during the development of a rating system such input variables can be used that does not change significantly in any manner in crisis. This logic, although it ensures that the capital result will be stable over time, will not be fit to use for business purposes, because on that field the most exact risk assessment worth more that uses components that can capture elevated risk levels in crisis periods. As a result of this proposal, the banks are expected to utilize a two-fold model scheme, one short-term rating model that maximize the predictive power and gives us a very exact risk level assessment for the coming year, and one long term rating system that has limited predictive power, but it can predict a general average level of risk over the next 5-10 years for the compete portfolio of the institution.

6. SUGGESTIONS (THEORETICAL AND PRACTICAL USAGE)

In this dissertation I analysed a specific problem of the Basel capital adequacy framework and why was it necessary to introduce some of the Basel III measures, namely the anticyclical capital buffer. It is stated in the regulation on an overall level that during the institutional capital calculation a long-term, through the cycle PD shall be calculated, however in reality it is hardly achieved. I analysed this effect in a comprehensive way, based on data, developing a long-term stable scoring system and calculating the PD over a given amount of time. I analysed the effects of the scoring system development and its minimum requirement to the capital level of a financial institution.

I showed in the analysis that the current methodological framework that utilize industry best practices is incapable to calculate a stable PD on portfolio level, either on the retail or on the corporate side. This effect is caused by the portfolio composition effect, that creates a cyclical portfolio-level PD from stable calculated PDs of the rating grades by migrating the portfolio from good categories (with stable PD) to bad categories (with stable PD). The resulting capital charge is unstable. The current regulation requires a minimum yearly rating intensity that destabilizes all types of PD calculation. Through the analysis I showed using a publicly available granular level corporate portfolio that we can create a very stable rating system that can perform well in crisis period as well as normal times that can provide us a rating that can be differentiated well over time. I showed that the better and quicker the re-rating is, the more procyclical the effect will be.

During the analysis of the results it could be seen that the analysed corporate portfolio the effect of the problem is not so great, however with specific adjustments that institutions are usually required to make – i.e. considering a behavioural aspect of the model, the effect on the capital level calculated with the ASRF framework can be also significant. This significant effect can be easily higher than the general solution of the anticyclical capital buffer defined in Basel III.

In the last section of the analysis I defined possibilities of coping this problem on a more consistent way. I showed the solution of Basel III and proposed two other solutions that are more consistent with the Basel logic of defining a stable TTC capital charge for the institution, based on the portfolio quality of it. My first proposal tried to redefine the requirement set laid out by Basel II. The price of this solution is that the use of the rating systems shall be abolished from the internal rating based approach, as the migration within the rating categories is what causes the problem. The exact calculation logic

of the default rate and loss rate, and the definition of the segmentation logic of a homogeneous portfolio shall be laid out by the regulation from which the capital minimum can be calculated. My second proposal details the minimum requirements of a rating system development and utilization that can provide stable PDs that might be used as an input for the capital calculation. Using these criteria will result in a very stable rating and a limited migration effect, because this allows only a limited number of rating revision, resulting in a portfolio-level stable PD. Migration cannot be allowed on the input data side, and rating shall be valid for more than one year, that shall be kept over a longer period of time, about one half of a typical economic cycle. This proposal abolishes the requirements for exact and minimum yearly re-rating, more stringent rules are to be defined.

In this dissertation it is showed that the current regulatory regime defines somewhat contradictory requirements for using the rating systems, and a specific handling needs to be implemented. The current changes in the Basel III proposals tries to find some answers to the problem but it tries the cure the effect and not the cause of the problem. It is questionable that it can be used by the national regulators in a correct and timely manner to avoid a next credit-related economic downturn or crisis. My proposals provide a more stable way of addressing this effect.

7. SCIENTIFIC AND EDUCATIONAL PUBLICATIONS, PRESENTATIONS (CONFERENCE, SYMPOSIUM, BOARD MEETING) FROM THE TOPIC OF THE THESIS

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