CONCENTRATION RISK: SETTING CREDIT LIMITS IN LOAN PORTFOLIOS, CASE OF MOROCCO

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Abstract

The latest biggest financial crisis reveals different weakness points over the global financial system. The concentration risk is one of many different risks that figured out by the regulators after the 2008 financial crisis. To deal with such a risk the regulators set up a dispositive of measures to control it. Therefore, we suggest in this paper a version of a mathematical model that optimize the allocation of capitals for a credit portfolio of a bank with taking into consideration the Moroccan regulatory environment.

Keywords: Concentration Risk, Credit Limit, Sectorial Limit, Optimization Problem, Expected at Default, Probability of Default, Value at Risk, Expected Loss

1. INTRODUCTION

The last economic and financial crisis, which has compounded since 2007, showed at which point the financial system is weak and complex. Among the major causes of the losses of the financial institutions, there was the risk of concentration. With the international scale, this risk weakens the health of the credit institutions and therefore it threats the economic stability of the countries. Thus, this risk becomes a priority and deserves a special attention for the regulators.

According to pillar II (directive 2006/48/CE), the risk of concentration is one of the specific risks that the regulators must control and supervise. In this respect, the banks must set up a device allowing the evaluation of the adequacy between their economic capital and their profile of risks and permanently maintain the level of capital considered suitable. It is here about the process "of evaluation of the internal capital" (ICAAP-internal Capital adequacy assessment process). In other words, the analysis must relate to all kinds of risks, including those which are not covered by pillar I, in particular the risk of concentration.

The risk of concentration is a banking term indicating in general, the distribution of the non-performing loans of a bank on a variety of the debtors with which banks lent money. In the majority of the cases, the risk of concentration is the risk posed with a financial institution by only one group or an individual whose total exposure can produce sufficiently an important potential loss to threaten the solvency of this institution.

This article is organized as follows: In the first section we will present the lawful framework which governs the aspect of the risk of concentration in the credit institutions in Morocco. In section 2, we will propose an analytical model for calculating the limiting amounts by portfolio of credit. The main of the model is to move towards an optimum composition of credit portfolio, considering the default rates, which means that the model decreases the overall default rate by reducing the proportion of portfolios with high risk and increases the weight of those with low or medium risk. As for the empirical analysis, this one will be detailed in the third section. We will calculate the limits by sector of activity based on a defined model, and after that, we will measure by using simulations the impact of the concentration risk on the economic capital.

2. LIMITS MANAGEMENT IN THE MOROCCAN REGULATIONS

Within the framework of the implementation of the second pillar of Basle II, Bank Al Maghrib (the central bank of Morocco and controlling authority of the Moroccan banks) worked out a reference frame of practices making it possible for the credit institutions to set up a device of management of the credit risk of concentration and to identify the potential sources such risks in order to ensure of it measurement, management, the follow-up and control. The regulatory framework that deals with that part known as the "directive on the device of management of the credit risk of concentration".

In addition, Bank Al Maghrib determined a coefficient of maximum risk of 20%, with a view to manage big risks and limit of the potential losses. The device of calculates of this coefficient is presented in the circular n°8/G/2012.

2.1. Circular n° 8/G/2012

The first Article of the circular n°8/G/2012 defines the concept of the "same recipient" like any person or entity or the whole of the persons or entities setting up a "group of dependent customers". That means a group of the persons or entities that are dependent so that it is probable that if one of them

encountered financial problems, the others would have problems of refunding. The risks incurred on this "same recipient" must be the subject of a monitoring known as "the big risks", which is expressed by the means of ratios of outstanding of risk by recipient compared to the amount of the equity of the credit institution.

According to article 2 of the circular, the credit institutions are held to observe, permanently on individual and consolidated bases, a maximum report or ratio of 20% between the total of the balanced risks incurred on the same recipient and their equity. Bank Al Maghrib, can nevertheless require the respect of a coefficient lower than this threshold for certain recipients or the whole of recipients of an establishment.

2.2. Device for concentration risk management of credit portfolio

In optics to good management of the concentration risk, the device of Bank Al Maghrib specifies the fundamental principles to follow:

- a monitoring adapted by the body of administration, the body of direction and by the operational entities ;
- policies and adequate procedures of the management of the credit concentration risk;
- a monitoring and systems of measurement of the credit concentration risk;
- a control and mitigation of the credit concentration risk;
- a suitable system of internal regulation.

2.2.1. Interne limit structure

According to the device related to the management of concentration risk, credit institutions must set up a system of internal limits, which make it possible to contain the concentration risk in credit portfolio. This system defines limits such as:

- the amount of the exposures, on the counterparties, expressed relatively to the equity, on the whole of the credits or for the net benefit of the institution ;
- the amount of the principal sector concentrations expressed relatively to the equity, on the whole of the credits or for the net benefit of the institution ;
- The share of the own capital stocks intern allocated with the credit concentration risk.

However, the system of limits must:

- Be compatible with the profile of the total risk of the institution ;
- Fix the total thresholds by specifying clearly the acceptable level of risk. These thresholds are approved by the body of administration and are revalued with regular intervals;
- Guarantee that the concentrations exceeding certain predetermined thresholds are quickly made available of the body of direction;
- Allow the body direction to control the exposure of the credit concentration risk compared to the pre-established thresholds.

2.2.2. Limit monitoring

An efficient information system is essential for the monitoring and the control of credit concentration. The communication of the measurements of the credit concentration risk is carried out with regular intervals and comprises precise comparisons between the current concentrations and the definite limits. The reports/ratios on the risk of concentration must be regularly examined by the bodies of administration and direction. They must include at least the following elements:

- Censuses of the exposures to the risk of credit towards the various counterparts;
- States related to the respect of the limits fixed by the institution ;
- Results and analysis of simulations of crisis;
- Conclusions of the control carried out, in particular by the internal audit and the auditors, on the policies and procedures of risk management of credit concentration like on the adequacy of the systems of measurement of this risk.

2.2.3. Crisis simulations

The financial institution periodically carries out simulations of crisis on their principal concentration risks on their credit portfolio. The results of these simulations of crisis must be analyzed in order to identify the risks of possible changes of the conditions of the financial market and the economic situation, which could have a negative effect on their own capital stocks and their benefits, and therefore to appreciate their capacity to face such situations. These simulations integrate the risks rising from the implementation of the techniques of CMR (Credit Risk Mitigation). The bodies of administration control the step conception and the results of crisis simulations and finally guarantee of the existence of urgently suitable strategy.

2.2.4. Reporting

The financial institution periodically communicates to Bank Al-Maghrib a specific reporting on the risk management of credit concentration risk. Concerning the big risks, the credit institutions are held to communicate to Bank Al Maghrib, on individual and consolidated bases, according to the methods laid down by it, the rough risks whose amounts, by beneficiary, are equal to or higher than 5% to their own capital stocks.

3. BASLE II AGREEMENT CONSTRAINTS

Within the framework of the permanent respect of the prudential ratio of equities on risk weighted assets as calculated in the Agreement of Basle II, the Committee of Basle stresses certain numbers factors being able to increase the exposure of the Group and thus to impact its ratio negatively:

- Residual risk: risk legal, documentary, or of liquidity being able to reduce the effect of the CRM techniques,
- Concentration risk: risk based on correlations between engagements and/or counterparties, not taken into account explicitly in the calculation of the RWA.

For these elements, it is asked in a generic way that the Group monitors and set up an appropriate mechanism of controls which can be the subject of a specific information request demanded by the

Official Authorities, as well on the calculated elements, as on the monitoring tools and process.

In the case of the concentration risk, it is required to be able to consolidate engagements along the following axes:

- Group dependent counterparties (i.e concept of recipient of the Big Risks),
- Economic sector,
- Geographic area,
- Internal rating.

For these elements, the agreement stipulates that limits must be calculated and followed within the framework of the monitoring of the concentration risk.

Hence, we suggest in the following section, a quantitative tool that calculate the limit by credit portfolio (group of counterparties, branch of industry…).

4. CREDIT LIMITS MANAGEMENT MODEL: ANALYSIS AND DEVELOPMENT

In this section, we will develop a mathematical model allowing financial institutions to determine, for a credit portfolio, the limits and the associated economic capital for credit risk.

4.1. Credit risk measure

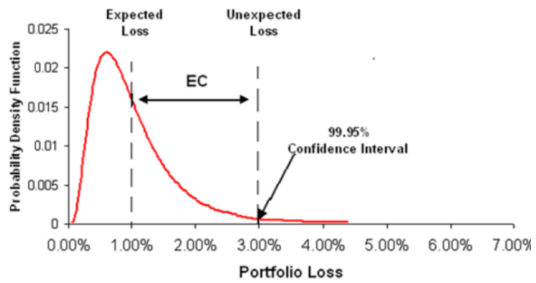
In general, we have two estimators that ensure the measurement of the credit risk related to the credit portfolio: the expected loss and the quantile loss. The expected loss is the average loss expected on the credit portfolio. It is calculated by adding the product of the potential losses and the associated probabilities.

However, the loss can obviously appear higher in the practice where the need for an estimator of the risk come. In practice, the most common estimator is the maximum loss associated to a confidence interval. Indeed, we will accept to bear in an adverse scenario with low probability of occurrence by measuring the loss (Value at Risk).We present the following major elements involved in the measurement of credit risk.

4.1.1. Credit loss distribution

The main target of our internal model is to determine the distribution of losses due to credit risk, in order to deduce the expected loss (EL) and the different quintiles. We consider 99.9% as confidence level to estimate the consumption of equity capital due to credit risk. The display of the distribution allows us to visualize the necessary elements (VaR, EL) on the allocation of economic capital. The below chart indicates these elements:

Figure 1. Portfolio loss vs PD Function



4.1.2. Probability of default (PD)

The probability of default measures the likelihood of a default over a particular time horizon (generally one year). It provides an estimate of the likelihood that a borrower will be unable to honor its debt obligations.

The measurement of this quantity is calculated in general through a counterparty rating, such that:

- Each borrower is scored.
- All counterparties within the same notation form a class of risk.

With each notation, a single probability of default is affected. Thus, all the counterparties, that have the same notation, will have the same probability of default associated with this notation. It is therefore sufficient to calculate the probabilities associated with each rating class. This probability for a rating grade is calculated by defining the number of defaults that have taken place on a year divided by the number of loans.

4.1.3. Exposure at default (EAD)

In the context of the operations between the bank and its clients, some client can in some cases not be able to repay their debts. In such a scenario, the bank recovers only one fraction of the lent amount. Thus, the bank must know its exposure to each loan, measured by the Exposure At Default. In this context, the EAD is defined as the loss undergone by the bank on a loan at the time of the default of its customer (see Benoit ROGER and Vivien BRUNEL 2014).

In this document, the present or future exposure represents a measure of risk expressed in terms of the nominal exposure (which means that the LGD is not taken into account). It takes account neither of possible recoveries, nor of the probability of occurrence of the default.

4.1.4. Hypothesis and basics principles

The basic principles leading to the determination of the distribution of losses probabilities are as follow:

- Each credit is analyzed and the associated risk is quantified on an individual basis (in general, all information for a credit is summarized by a rating) in order to determine directly the probability of default over a particular time horizon.
- The term commonly used for credit risk is the year. This practice is based on the assumption that the time required for a bank to separate bad debts or to change the composition of its balance sheet is at least a year.
- The correlation is determined by the variance of default distribution. This model considers that the defaults rates are continuous random variables. Besides, it recognizes that the defaults are correlated (in particular by factors such as the economic situations). It does not explicitly model correlations (among others because they are unstable in time and therefore highly dependent on the chosen study period) between each debtor. However, incorporating the effects of concentration (correlation between sectors) through the volatility of default rates and sector analysis. The economy is supposed to be divided into economic sectors which are evolved independently of each other. Hence,

each client is affected to different sector of the economy. The correlation between two clients is calculated from the distribution of defaults of each client and their sector decomposition.

4.2. Elaboration of the limits concentration

The final purpose consists on the development of the limits of concentration per counterparty, sector, geographical area and by rating. To be done, we started by establishing the limits by sector. Then, by following the same principle or technique we can find the limits by rating and geographical area.

To simplify the calculations we will take into consideration the following hypothesis:

• E_a is the exposure to the risk of credit of counterpart A and p_a its probability of default.

• z_a is a random variable distributed according to "Poisson distribution" with parameter p_a (approximation of a law of Bernoulli of parameter p_a when $p_a <= 15$ %. It is "a careful approximation" because the standard deviation of a random variable according to "Poisson distribution" is $\sqrt{(p_a)}$, which is higher than the standard deviation of a random variable according to "Bernoulli distribution" $\sqrt{(p_a(1-p_a))}$.

The loss of the portfolio is a random variable modeled by:

$$L = \sum_{a \in A} z_a E_a \tag{1}$$

This random variable is not distributed according to a known form but it can be studied empirically by simulating each terms separately, and by adding them thereafter.

Therefore, we need to determine the characteristics of this random variable:

• Firstly, the expected loss is given by: $E(L) = \sum_{a \in A} p_a E_a$

• Secondly, the variance of L under the assumption of the independence of the counterparties, is given by:

$$\sigma^2(L) = \sum_{a \in A} p_a E_a^2 \tag{2}$$

• Finally, the standard deviation of L is then : $\sigma(X) = \sqrt{\sum_{a \in A} p_a^2 E_a}$

Moreover, we define ξ(α) as the multiplier of the loss distribution at a some confidence level α. This parameter is deducted from the following formula:

$$P\big(L < E(L) + \xi(\alpha)\sigma(L)\big) = \alpha \tag{3}$$

This formula specifies the probability of loss due to the limited risk by the term $E(L) + \xi(\alpha)\sigma(L)$.

Using the Monte Carlo simulation of the VAR, we found:

$$\xi(\alpha) = \frac{Var(\alpha) - EL}{\sigma(L)} \tag{4}$$

Thus, the contributions on the global risk with confidence level α for each counterparty are given by:

$$E(x_a E_a) + \xi(\alpha)\frac{\partial \sigma}{\partial E_a} E_a \tag{5}$$

In other words:

$$p_a E_a + \xi(\alpha)\frac{p_a E_a^2}{\sqrt{\sum_{a \in A} p_a E_a^2}} \tag{6}$$

Hence, the equity consumption of the counterparty risk is the risk contribution with 99.9% confidence level. Therefore, the risk contribution of an industry is obtained by adding the risk contributions of each counterparties belonging to it.

Let E_s be the risk exposure of the sector S, then the risk contribution of this (with a given confidence level α) is measured as follows:

$$RC_k = p_a E_a + \xi(\alpha)\frac{p_a E_k^2}{c_k} \tag{7}$$

Such that:

• $p_k = \frac{\sum_{a \in k} p_a E_a \sum_{a \in k} E_a}{\sum_{a \in k} E_k}$ is the mean probability default of a sector k.

• $c_k = \frac{\sum_{a \in k} p_a E_a \sum_{a \in k} E_a}{\sum_{a \in k} p_a E_k^2}$ is the concentration index of the sector k.

4.3. Resolution of optimization problem

To determine sectorial limits, we must solve the problem of constrained optimization: we seek the portfolio that minimizes the economic capital consumed by the portfolio. For this reason, we need to minimize the expected loss, which is equivalent to minimize the dispersion of the aggregate loss of the overall portfolio.

The system to be solved is as follows:

$$\begin{cases} \min \sigma^2 = \sum_{k=1}^{K} \frac{p_k E_k^2}{c_k} \\ s/c \sum_{k=1}^{K} E_k = E \end{cases} \tag{8}$$

That is, we must minimize the loss while setting the overall portfolio exposure to a certain level.

The "Lagrangian" of the system is given by:

$$L(\lambda, E_k) = \sum_{k=1}^{K} \frac{p_k E_k^2}{c_k} - \lambda\Big(\sum_{k=1}^{K} E_k - E\Big) \tag{9}$$

The resolution of this program undertaken to the following result:

$$E_k^l = \frac{c_k * \lambda}{2 p_k} \tag{10}$$

Such that:

$$\lambda = \frac{2E}{\sum_{k=1}^{K} \frac{c_k}{p_k}} \tag{11}$$

And:

$$\frac{E_k^l}{E} = \frac{c_k}{p_k \sum_{k=1}^{K} \frac{c_k}{p_k}} \tag{12}$$

Therefore, the sector exposure limit is expressed through the following formula:

$$RC_k^l = p_k E_k^l + (Var(99\%) - EL) * \frac{E_k^l}{E} \quad (13)$$

The sectorial limit corresponding to a capital allowance is to the consumption of equity to the optimum.

5. EMPIRICAL ANALYSIS

5.1. Description

The main of the empirical analysis is to test, on a basis of data simulated, the results of the model on the fixing of the sectorial limits. Indeed, it is supposed that the bank, on which we made simulations, has a total exposure of 400 billion MAD which corresponds to a consumption in equity of 14 billion MAD. Concerning the sectors chosen in the portfolio of simulation, we selected those that have a Probability of Default, in other words we limited our choice on the noted sectors. The total outstanding of the studied portfolio is 60.3 billion MAD and contains 3,572 companies which are divided between large, small and medium-sized companies.

The table shows that the sector more represented is the real estate, followed by the Food industry, Commerce and Manufacturing industry (strong presence of the small companies.)

Table 1. Breakdown of assets by activity sector

Sector	*Total exposure (billion MAD)*	*Number of companies*	*Exposure %*
Real estate	17 121	891	28%
Food and Fishing industry	10 991	412	18%
Commerce	9 668	943	16%
Manufacturing industry	6 484	376	11%
Mechanics and steel industry	4 270	146	7%
Communication	3 221	92	5%
textile, clothing and leather industries	1 783	255	3%
electrical and electronic industry	1 877	103	3%
Transportation	1 796	204	3%
chemical industry	677	65	1%
pharmaceutical industry	2 456	86	4%
Total	60 345	3572	100%

5.2. Estimation of sector limits

The final purpose of the model is to find an optimal combination of branch of industries that reduce the total risk by weakening the share of the sectors with a high-risk rate while increasing the weight of those having a low risk rate.

Table 2. Elements of limits by activity sector

Sector	*Exposure (billion MAD)*	*Profile risks sector (PD)*	*Capital*	*Limit*	*Overtaking*	*Share of the going available %*
Real estate	17 121	1.62%	716	15 504	-1 617	**-2.68%**
Food and Fishing industry	10 991	1.25%	563	13 255	2 265	3.75%
Commerce	9 668	1.81%	509	10 586	918	1.52%
Manufacturing industry	6 484	1.58%	302	6 596	112	0.19%
Mechanics and steel industry	4 270	1.65%	178	3 820	-450	**-0.75%**
Communication	3 221	2.20%	202	3 891	670	1.11%
Textile, clothing and leather industries	1 783	2.06%	89	1 765	-18	**-0.03%**
Electrical and electronic industry	1 877	1.51%	77	1 706	-171	**-0.28%**
Transportation industry	1 796	0.69%	82	2 214	418	0.69%
Chemical industry	677	1.63%	33	718	41	0.07%
Pharmaceutical industry	2 456	0.76%	107	2 855	399	0.66%
Total	60 345	1.56%	2 860			

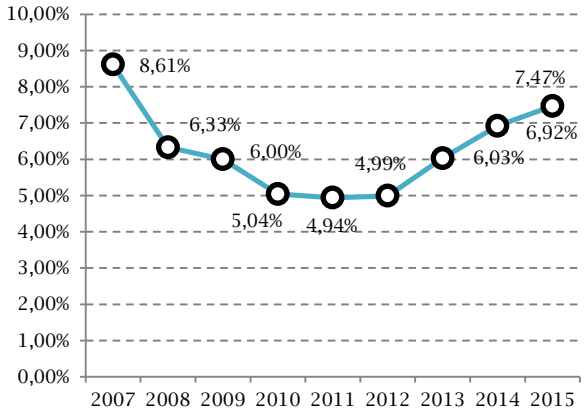
The table 2 shows our data base and illustrates for each sector the whole of all the elements taking into consideration for the estimation of the sectorial limits. The second column represents the real exposure for each sector at time when the exercise of the limits is carried out. The third column, gives an idea on the profile risks sector, this last is measured by the probability of the default of the companies of the studied sector, balanced by their outstanding. The fourth column presents the appetite for the risk relatively to a given sector, measured by the consumption in own capital stocks calculated for each sector. By considering these elements, the theoretical limit and the available overtaking are given in columns 4 and 5. The last column, gives the share of the overtaking respectively to the total outstanding (60,345 billion MAD). A negative overtake for a sector, shows that this one concentrates a part of outstanding not covered by the consumption in own capital stocks.

The table above shows a concentration on the level of the sector of real estate. Indeed, the exposure of the bank for this sector is 17 billion MAD. Sight the profile of the high risk that this sector represents (a PD of 1.62%), the model suggests to lower the concentration on this sector and limiting the exposure to 15.5 billion MAD. The 1.5 billion MAD left will be directed towards to other sectors. With less degree, our model, proposes to draw back a part of outstanding on the following sectors: Mechanics and Steel industry, Textile, Clothing and Leather industry, Electric and Electronic industry. However, the model supports the Commercial sector by suggesting an allocation of 13.2 billion MAD instead of 11.9 billion MAD currently distributed. Indeed, the Commercial sector as well known is a diversified sector (a PD of 1.25% which is lower than the average portfolio 1.56%). For the following sectors such as Manufacturing industry, Chemical and Para-chemical industry and Pharmaceutical industry, the statistics given by the model are very close to the granted authorizations.

5.3. Sensitivity sector limits by risk profiles

The below graph displays the evolution of the contentiality rates in Morocco from 2007 to 2015 with an average up to 6.4%. The contentiality rate is defined by the relationship between the non-performing loans and the total of loans of the bank. The graph shows a downward trend of the contentiality rate between 2007 to 2010, then the rate fluctuate moderately until 2012 and reached the top of 4.94%, and after it rose considerably to reach 7,4% in 2015 (wich is +0.55 point compared to December 2014, against 1 point between 2012 and 2014).

Figure 2. The evolution of the contentiality rate in Morocco from 2007 to 2015



Source: Professional Group of Moroccan Banks PGMB

We will use the concept of contentiality as criterion of default to simulate the sectorial limits. Through this analysis we illustrate how the evolution of the default rates impacts negatively or positively the sectorial limits fixed by the model. However, the posted defaults covers all the portfolio and we do not have specific information by sector. To solve this problem, we will calibrate the PDs that are already existed by the new default rate for each sector. For this purpose, we use the following formula:

$$pd_s^{scaled} = pd_s^{hist} \frac{0{,}064}{\sum_{s=1}^{S} w_s . pd_s^{hist}} \quad (14)$$

The table and the graph below (table 3) give the default rate per branch of industry from 2007 to 2015.

As we can see from the chart, we can divide the graph to a three periods :

- From 2007 to 2010: period when the defaults rates for all the sector are falling.
- Period between 2010 and 2012: period when the defaults rates for all the sectors remain stable.
- Period between 2012 and 2015: period when the defaults rates for all the sectors increase.

5.3.1. Calculus of sectorial limits per default year

Table 3 shows the defaults rates that will be used for the calculation of the sectorial limits.

Figure 3. The evolution of the contentiality rate per sector in Morocco

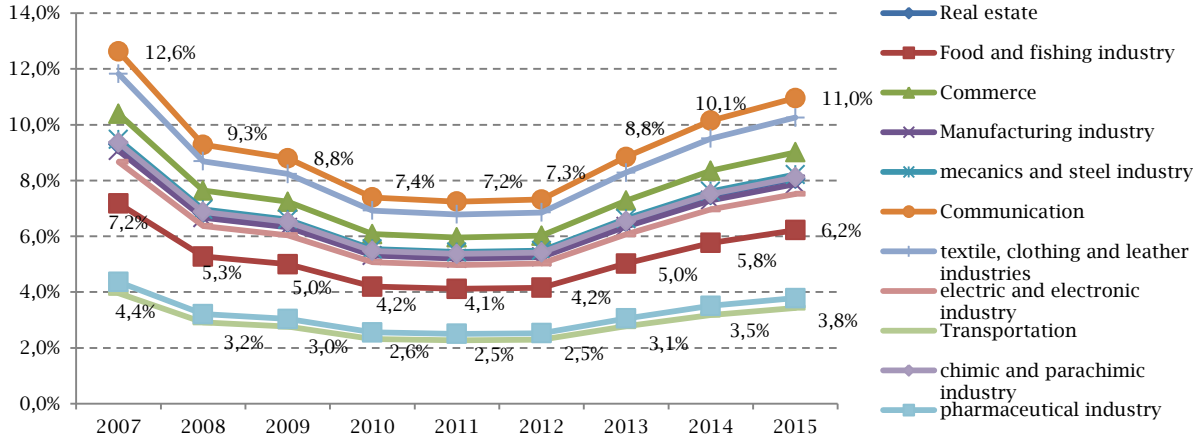


Table 3. Default rate per year and by activity sector

Sector	*Exposure %*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Real estate	28%	9.3%	6.8%	6.5%	5.4%	5.3%	5.4%	6.5%	7.5%	8.1%
Food And Fishing Industry	18%	7.2%	5.3%	5.0%	4.2%	4.1%	4.2%	5.0%	5.8%	6.2%
Commerce	16%	10.4%	7.6%	7.2%	6.1%	6.0%	6.0%	7.3%	8.4%	9.0%
Manufacturing Industry	11%	9.1%	6.7%	6.3%	5.3%	5.2%	5.3%	6.4%	7.3%	7.9%
Mechanics And Steel Industry	7%	9.5%	7.0%	6.6%	5.5%	5.4%	5.5%	6.6%	7.6%	8.2%
Communication	5%	12.6%	9.3%	8.8%	7.4%	7.2%	7.3%	8.8%	10.1%	11.0%
Textile, Clothing And Leather Industries	3%	11.8%	8.7%	8.2%	6.9%	6.8%	6.9%	8.3%	9.5%	10.3%
Electric And Electronic Industry	3%	8.7%	6.4%	6.0%	5.1%	5.0%	5.0%	6.1%	7.0%	7.5%
Transportation	3%	4.0%	2.9%	2.8%	2.3%	2.3%	2.3%	2.8%	3.2%	3.4%
Chemical And Para-Chemical Industry	1%	9.4%	6.9%	6.5%	5.5%	5.4%	5.4%	6.6%	7.5%	8.1%
Pharmaceutical Industry	4%	4.4%	3.2%	3.0%	2.6%	2.5%	2.5%	3.1%	3.5%	3.8%
Total	100%	8.9%	6.6%	6.2%	5.2%	5.1%	5.2%	6.3%	7.2%	7.8%

Table 5 is the result of the model calculation. As we can see that the limits assigned for each sector are strongly impacted by the degree of their contentiality. It is seen for example that the sector of real estate passed from a limit of 16.8 billion MAD (portfolio 5 with a PD of 5.34%) to a limit of 13.8 billion MAD (portfolio 1 with a PD of 9.30%).

Table 4. Limits per portfolio by sector activity

Sector	*Portfolio*								
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Real estate	13 830	15 564	15 852	16 753	16 852	16 802	15 825	15 075	14 646
Food and fishing industry	12 033	13 298	13 504	14 139	14 209	14 174	13 485	12 946	12 634
Commerce	9 369	10 630	10 841	11 506	11 580	11 543	10 822	10 272	9 960
Manufacturing Industry	5 894	6 621	6 741	7 118	7 160	7 139	6 730	6 416	6 236
Mechanics And Steel Industry	3 403	3 835	3 907	4 132	4 157	4 144	3 900	3 713	3 606
Communication	3 395	3 909	3 997	4 276	4 307	4 291	3 989	3 762	3 634
Textile, Clothing And Leather Industries	1 547	1 773	1 811	1 932	1 946	1 939	1 807	1 708	1 652
Electric And Electronic Industry	1 529	1 712	1 743	1 837	1 847	1 842	1 740	1 661	1 616
Transportation	2 080	2 219	2 240	2 306	2 313	2 309	2 238	2 181	2 147
Chemical And Para-Chemical Industry	640	721	734	776	781	779	733	698	678
Pharmaceutical Industry	2 669	2 861	2 892	2 983	2 993	2 988	2 889	2 809	2 762
Total	8.9%	6.6%	6.2%	5.2%	5.2%	5.2%	6.3%	7.2%	7.8%

5.4. Sensitivity of economic capital to concentration effect

In order to measure the impact on the economic capital of the portfolios more concentrated than the reference one, we must build a sequence of six portfolios, each one with an increased concentration of the sector compared to the precedent. For this purpose, one gradually increases the concentration of the sector in our portfolio of reference by using the following algorithm. In each stage, we remove X exposures of all the sectors and add them to a sector previously selected. This procedure is repeated until one arrives at a portfolio with the highest possible concentration (portfolio 6 in our case).

The table 5 represents a sequence of seven portfolios with an order ascending of concentration per sector.

Table 5. The effect of the sectorial concentration on the economic capital

Sector	*Exposure %*	*Portfolio 1*	*Portfolio 2*	*Portfolio 3*	*Portfolio 4*	*Portfolio 5*	*Portfolio 6*
Real estate	28.4%	26.0%	23.0%	21.0%	19.0%	15.0%	9.0%
Food and fishing industry	18.2%	38.0%	48.0%	57.0%	63.0%	72.0%	84.0%
Commerce	16.0%	10.0%	8.0%	7.0%	6.0%	5.0%	4.0%
Manufacturing industry	10.7%	8.0%	6.0%	5.0%	4.0%	3.0%	2.0%
Mechanics and steel industry	7.1%	0,04	3.0%	2.0%	1.0%	0.0%	0.0%
Communication	5.3%	4.0%	3.0%	2.0%	2.0%	1.0%	0.0%
Textile, clothing and leather industries	2.9%	2.0%	2.0%	1.0%	1.0%	1.0%	0.0%
Electric and electronic industry	3.1%	2.0%	2.0%	1.0%	1.0%	1.0%	0.0%
Transportation	3.0%	2.0%	2.0%	1.0%	1.0%	1.0%	0.0%
Chemical and para-chemical industry	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%
Pharmaceutical industry	4.1%	3.0%	2.0%	2.0%	1.0%	0.0%	0.0%
HHI	17.6	24.1	35.2	51.5	61.7	68.4	94

The increase in the concentration of the sector is also reflected by the index of Herfindahl-Hirschman (HHI, to see Hirschmann (1964).), given in the last line which is calculated on the level of the Impact sector on the economic capital. One defines the economic capital as being the difference between the centile of a 99.9% (VAR) of the distribution of loss and the expected loss (figure 1). The results of simulation are given in table 6. We observe that for the Corporate sample that the economic capital increased by 20% for portfolio 2 compared to that of reference. The economic capital for portfolio 5 increased by 37% compared to the reference. These results show the importance to take into account in the effect of the sectorial concentration during the calculation on the economic capital.

Table 6. Sequence of seven portfolios with an order ascending of concentration per sector

EC (billion MAD)	*Reference of portfolio*	*Portfolio 1*	*Portfolio 2*	*Portfolio 3*	*Portfolio 4*	*Portfolio 5*	*Portfolio 6*
Scope of the study	7.6	8.6	9.3	9.9	10.1	10.5	11.5
Total of portfolio	7.9	8.1	8.4	8.6	8.7	8.8	9.1

Notes: Loans to the corporate segment around 25% of loans, 70% for other credit

In general, the portfolio of the company includes or understands only one fraction of the portfolio of loans (which also contains loans with the sovereigns, other banks and private detail customers). Although the increase in the concentration of the sector can have a significant impact on the economic capital of the credit portfolio to the companies, it can have an impact much weaker in terms of portfolio total credit of the bank. For a significant comparison, we suppose that the credit portfolio of company understands 25% of the portfolio of total credit and that the banks must

hold own capital stocks to a total value of 8% of their total portfolio. By supposing that, there are no advantages of diversification between the exposures on the companies and other credits of the bank, the economic capital of the total of the portfolio can be given as being the sum of the EC for the exposures on the companies and the EC for the remaining exposures. The results for the total portfolio of the bank are also presented in table 6. As envisaged, the impact of an increase in the concentration of the sector is much less severe when one looks at the EC for the whole of the portfolio. For example, the economic capital for portfolio 5 increases approximately 16% compared to the reference, instead of 37% which mean that only the portfolio of the company is taken into account.

6. ANOTHER ANALYSIS STRATEGIES

The purpose is to lay out, for some strategies, of a consolidated vision of the risks by group of counterparties.

6.1. Limit per geographic area

The limits will be fixed for each geographical area and each country as illustrated in table7.

Table 7. Credit limit per geographic area

Geographical area	*Country*	*Limit*	*Exposure*	*Exceeded available*
Area X		400	500	-100
	country X1	100	350	-250
	country X2	100	50	50
	country X3	100	70	30
	country X4	100	30	70
Area Y		170	140	30
	country Y1	0	10	-10
	country Y2	50	30	20
	country Y3	100	90	10
	country Y4	20	10	10

6.2. Limit per internal note

The limit can be fixed for an internal notes or/and for a class of internal notes. In the following example, it is very important to understand that:

- For the class of notes "investment rank" (BBB - and better) the limit functions as a threshold: the share of the portfolio noted better than BBB - must be equal or higher than the limit;
- For the class of notes in lower part of the BBB - (including not noted) the limit functions as a ceiling: the share of the portfolio noted in lower part of the BBB- should not exceed the limit. We illustrate this idea in this table below:

Table 8. Credit limit per internal note

Internal rating class	*Internal note*	*Minimum limit (%)*	*Total exposure*	*exposure %*	*Exceeded available*
between AAA+ and BBB-		90%	950	95%	5%
	AAA		400	40%	
	AA+		200	20%	
	AA		100	10%	
	AA-		100	10%	
	BBB+		50	5%	
	BBB		50	5%	
	BBB-		50	5%	
		Maximum limit			
between BB- and C-		10%	40	4%	6%
	BB+		10	1%	
	BB		2	0%	
	BB-		2	0%	
	B+		2	0%	
	B		2	0%	
	B-		2	0%	
	CCC+		2	0%	
	CCC		2	0%	
	CCC-		2	0%	
	CC+		2	0%	
	CC		2	0%	
	CC-		2	0%	
	C+		2	0%	
	C		2	0%	
	C-		2	0%	
	D		2	0%	
Not noted	Not noted	0%	10	1%	-1%
Total exposure			1000	100%	

7. CONCLUSION

The minimal requirements of own capital stocks for the credit risk in IRB approach of Basle II suppose implicitly that the portfolios of credit of the banks are well diversified in the branches of industry. The risk of concentration in certain branches of industry is covered by pillar 2 (process of prudential monitoring) of the framework of Basle II. (See BCBS (2004b), paragraphs 770-777.).

On the basis of an existing portfolio, we sought to find an optimal composition of the credit portfolio which make possible to the bank to post a better profitability and to optimize the consumption of the equities, by considering the effects of diversification and the rating.

With this intention, we developed a model, which made it possible to answer the following question: according to the risk profile of a given portfolio and bank's risk appetite, what would be the limit exposure to allocate for this portfolio? We have to consider portfolio of branch of industry and thanks to our data we could calculate the sector limits. The results show that the model supports the sectors with weak or average rate of risk and penalizes the sectors having a high rate of risk.

In order to measure the impact on the economic capital of the portfolios more concentrated than the reference one, we built a sequence of six portfolios, each one with an increased sector concentration relatively to the precedent. The results show that compared to the reference portfolio, the economic capital for the concentrated ones can increase of almost 37%.

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