From Basel I to Basel III in the banking system: A brief theoretical presentation

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Summary

In this article, the regulatory framework which covers the credit institutions' operation over time is briefly presented targeting banking stability. That is, the main initial directives of Basel I (BCBS, 1988, 1996 & 1998) are presented, which appear before the existence of the euro, as well as the main changes published by the Basel Committee on Banking Supervision (BCBS), which became known as Basel II (BCBS, 2004 & 2006), but also the changes established as Basel III (BCBS, 2011, 2016, 2017, 2018, 2019 & 2021). In the framework of Basel III, the accompanying liquidity rules for banks are also presented (BCBS, 2013 & 2014). Finally, in conclusion, there is some criticism of this continuous effort for this rigorous regulatory control of the banks.

Keywords: *Basel I/II/III, Capital requirements, Liquidity, Banking system*

JEL Classification: *G21, G28*

1. Introduction

The advent of Basel I in 1988 was not accidental. It was mainly related to the rapid development and gradual internationalization of the credit system and of financial instruments, which gradually began from the mid-80s onwards. Starting from the USA, it was Aglietta (1996) who pointed out that apart from the very low capital ratio of the banks,[1] in relation to the Balance Sheet assets, some further problems were created by a significant credit expansion that was not accompanied by corresponding guarantees of collateral. In the same period ('80s), we have the widespread appearance of new types of bank liabilities, such as certificates of deposit (CDs), which could finance broader "credit exposures" of the banks. However, these new liabilities were more volatile, in terms of value, than the traditional means used for lending (e.g., customer deposits). An important role, among others, for this tricky situation was also the increase in banking competition, which negatively affected the returns on bank loans. All this, as Aglietta also pointed out, led to a downward credit rating of commercial banks after the mid-80s, not only in the USA, but also in the United Kingdom. This fragile situation led to the initiative undertaken by the Basel Committee on Banking Supervision (BCBS hereafter) for an international "convergence" of the main rules for calculating the capital requirements of banks in the developed economic world (Gortsos, 2011).

In the following sections 2 to 4, we present the main directives and then their changes and/or supplements from the original Basel I to those of Basel III. This can be considered as an extension of the article by Sbârcea (2014) as well as the article by Vousinas (2015) on the credit risk, market risk, operational risk, and capital adequacy. Section 5 also presents the additional liquidity rules that were specifically linked to the Basel III directives. Finally, in section 6, there are some brief criticisms of this continuous effort for the rigorous regulatory control of the banks.

2. Origins: The general principles of Basel I

2.1. The calculation of credit risk

2.1.1. BCBS, 1988

The BCBS in 1987/8 initiated a process which required the imposition of different weights on different types of

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– Opinions or value judgments expressed in this article are the author's own and do not necessarily reflect those of the Centre of Planning and Economic Research.

1. Based on the analysis of Jordà et al. (2021), the relatively low capital ratio of banks was a post-war characteristic of the developed world.

credit expansion for all countries with a developing financial system. This was made possible through an algebraic transformation of the various elements within the Balance Sheet (assets), so that they take the form of a measurable credit risk ("credit exposure") of the Balance Sheet. Thus, for the first time, the relationship between the capital requirements of the equity funds and the total weighted assets of the banks (TRWA)[2] was revealed. In fact, four (4) credit risk categories were initially created (see Table I1, Annex I). In addition, there were several weighting factors for the off-Balance Sheet assets of the banks (see Table I2, Annex I). The obvious purpose of the specific classification and weighting off and on Balance Sheet assets was an attempt, through supervision, for a homogeneous treatment of the credit risk of the banking institutions of the ten most developed countries (G-10). In addition, the first simple form of credit risk calculation with the corresponding mitigation offered by a certain financial collateral appeared.[3] The final date of implementation of the first edition of the Basel [BIS] Committee was set at 31-12-1992.

2.1.2. BCBS, 1998

With the BCBS edition of 1998, in the analysis of credit risk, the value of the mitigation of a bank's assets was added with more detail. More accurately, the bank's real exposure to an asset was clearly influenced by the valuation of its financial guarantees, which, however, at the same time were instruments of its trading book.[4] The valuation of these financial tools (or guarantees) was calculated in detail following the two parts of the *current exposure* method.[5] More analytically:

- the total replacement cost from the "closing" of the contracts to which the bank is exposed with its counterparties at current prices plus

- an additive ("add on") term, based on the residual future value of these financial contracts or products, multiplied by a given exposure factor (see Table I3, Annex I).

The second part, i.e., the future exposure (the "add on" factor), was calculated based on the nominal value of the financial contract with a coefficient that was affected by the time until this contract's maturity. Its added value is, of course, related to the fact that a financial contract until its expiration includes volatility, which is an element of the risk.

2.2. The calculation of market risk

2.2.1. BCBS, 1996

In the BIS Commission's original edition (BCBS, 1988), the question of market risk was not highlighted until later (BCBS, 1996). But we could say that in the 1996 edition, there is a detailed discussion on how to calculate risk from exposure to a series of financial products in the trading book, such as interest rates, foreign exchange, gold, tradable products, and shares, etc. With this edition, a more detailed presentation regarding the resulting capital charges begins in relation to market risk.[6] This risk was mainly related to losses from the financial products —due to changes in their prices— which were included in the trading portfolio of banks. The use of alternative methods of assessing the market risk[7] was also presented in detail in this

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2. The total weighted risk (TRWA) of a bank's Balance Sheet had the following simple algebraic form:

$$TRWA = \sum_{i=1}^{n} \{[W_1 \times E_1] + [W_2 \times E_2] + \ldots + [W_n \times E_n]\} \qquad i = 1 \ldots n$$

where: *TRWA* (total risk weighted assets) was the sum of the weighted assets of a bank; E_i was an individual Exposure (e.g., asset without compensation by a guarantee) of the bank's Balance Sheet; W_i was an attached weighting factor to each category of the bank's assets.

3. Algebraically, the simple form of credit risk calculation with the corresponding mitigation offered is

$$E_i^f = \max\{0, [E_i - C]\}$$

where: E_i^f refers to the bank's Exposure (as an amount) of a specific Asset, i, after its hedge with an existing guarantee, E_i refers to the Exposure (as an amount) of the specific Asset before its final hedge with a guarantee, C refers to the amount of the specific financial guarantee for the credit hedge.

4. In this way, the valuation of financial products (tools) concerns both credit and market risk.

5. There were other methods of calculating market risk (e.g., the *original exposure* method) but the *current exposure* method was mainly recommended.

6. Of course, the market risk, although it was calculated as a capital charge, was not yet expressed in the denominator of the banks' capital adequacy ratio.

7. The market risk for each bank's trading portfolio contained the following elements: interest rate risk, equity risk, foreign exchange risk, commodity risk and option risk.

BCBS edition. These methods were the following two: a) the *Standardized Measurement* method (SMM) and b) the *Internal Models* method, which included the use of the *Value-at-Risk* [VaR] approach. Finally, in the same edition, it is pointed out that the supplementary capital (Tier III) was initially introduced by the BIS Commission for this purpose.

2.3. The calculation of capital adequacy

2.3.1. BCBS, 1988

Another element that the BIS Commission defined with this edition was the precise determination of the elements of the equity that constitute the capital of the banks. More specifically, by the end of 1992, in terms established by the 1988 Accord, banks' equity was classified as Core capital or Tier I and Supplementary or Tier II. Core or Tier I capital contained the following two (2) elements:

- Paid-up capital/common stocks and
- Reserves (disclosed reserves).

As regards the Supplements funds or Tier II, they consisted of the following five (5) elements[8]:

- Undisclosed reserves
- Asset revaluation reserves
- General provisions
- Hybrid capital instruments
- Subordinated debt.

Now based on the weighted assets of the banks and the supervised funds (Tier I and II), the minimum capital requirement was determined to satisfy the following simplified capital adequacy ratio (CAR):

$$\frac{Tier\ (I\ \&\ II)}{\sum (Risk\ Weighed\ Assets)} \geq 8\% \qquad (1)$$

Note: includes On- and Off- Balance Sheet convertible assets.

Inequality (1) should, by the end of 1992, be equal to or greater than 8%. In other words, the supervised equity capital of the bank should be equal to or greater than 8% of the weighted position of the credits of the bank's assets.

2.3.2. BCBS, 1998

In this improved edition of Basel I, there was mainly a more extensive presentation of how the individual elements of the equity capital of each bank should be composed. This mainly included a breakdown of equity into core funds (Tier I), supplementary funds (Tier II) and additional supplementary funds (Tier III). Annex VI presents these data in more detail.

3. From Basel I to Basel II

The transition from Basel I to Basel II capital requirements followed a series of individual directives that resulted in a comprehensive version, by the BCBS, which became known as "Basel II: The Revised Framework: a comprehensive view' [BCBS (2006)[9]]. As Borowicz (2023) points out, all revisions began with the finding, by some BIS Commission economists, that the existing Basel I models underestimated the capital needs in case the probability of a financial crisis increased. Extensive consultation with representatives of the banking sector, supervisory organizations, central banks, and external observers also played an important role in this revision to develop, with the best possible way, the capital requirements adapted to each risk. The 2006 BCBS edition mainly dealt with upgrades in the way loan as well as trade portfolios of banks could be controlled.

In addition, Basel II contained the three (3) pillars for bank control. Specifically:

- Pillar I: Minimum Capital Requirements
- Pillar II: Supervisory Review Process
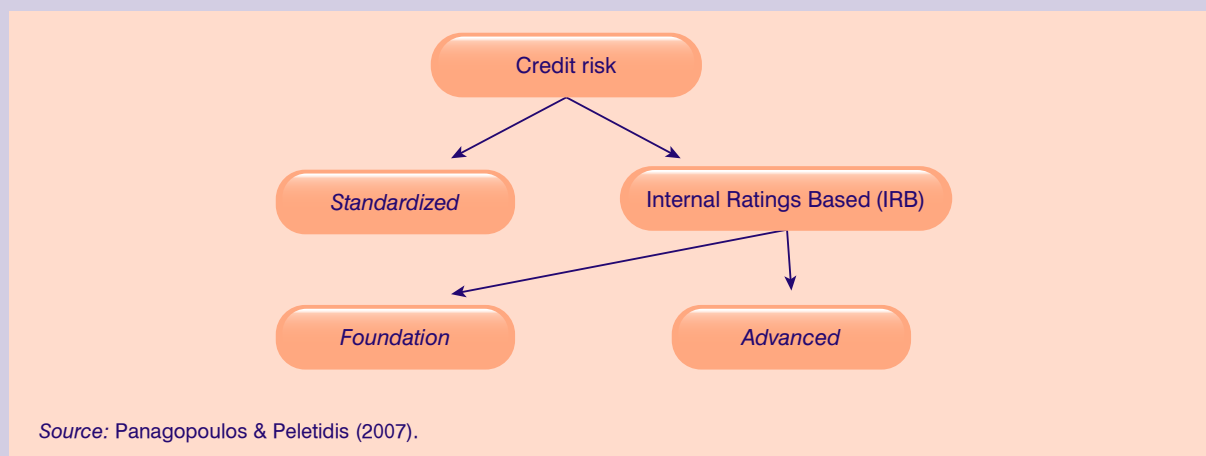- Pillar III: Market Discipline.

Starting from Pillar I, we should mention that the BCBS (2006) edition enriches the bank control with more categories and weightings of the assets, with different and more complex ways of algebraically determining the required equity capital. In addition, we had the introduction of the concept of operational risk in the analogous calculation of the capital requirements.

But the BIS Committee in the 2004 and especially in the 2006 editions (BCBS, 2004 & 2006) did not simply limit themselves to the creation of some new credit risk weighting categories but, as we already mentioned, enriched the way of calculating the capital require-

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8. BCBS (1996) also makes the first optional reference to the existence of supplementary funds (Tier III) with quantitative restrictions vis-à-vis the other funds, Tier I and II.

9. The BCBS (2006) edition, as noted on the cover paper, essentially contains the editions: BCBS (1988, 1996 & 2004).

DIAGRAM 1
Methods of calculating credit risk based on Basel II

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                        ┌──────────────┐
                        │  Credit risk │
                        └──────┬───────┘
              ┌────────────────┴────────────────┐
              ▼                                 ▼
      ┌──────────────┐              ┌──────────────────────────┐
      │ Standardized │              │ Internal Ratings Based   │
      └──────────────┘              │        (IRB)             │
                                    └────────┬──────────┬──────┘
                      ┌──────────────────────┘          │
                      ▼                                  ▼
              ┌──────────────┐                   ┌──────────────┐
              │  Foundation  │                   │   Advanced   │
              └──────────────┘                   └──────────────┘
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Source: Panagopoulos & Peletidis (2007).

ments against the banks' credit risk with two (2) new methodologies: the *Standardized* approach and the *Internal Ratings Based* (IRB hereafter) approach. In fact, the IRB approach was further subdivided into the *Foundation* approach and the *Advanced* approach. Diagram 1 shows the interconnection of the above methodologies in the calculation of credit risk.

Below we will briefly present the different methodologies that led to the quantification of credit risk in different asset categories, which primarily affected the quantitative result of the denominator of inequality (2) [see section 3.4.1] and, by extension, the required numerator, e.g., Tier I, in the banks' capital adequacy ratio (CAR) to keep the minimum capital requirement rate at 8% at least.

3.1. The calculation of credit risk

3.1.1. BCBS, 2006

3.1.1.1. In the Standardized method

Based on this Basel edition, in the case of using the specific methodology to calculate the weighted credit risk of a bank, specific steps were proposed that should be implemented. In more detail, each asset of the loan portfolio that contains credit risk was weighted with risk coefficients that differ based on:

- the type of creditor, e.g., whether they are governments, central banks, development or commercial banks, financial firms, businesses, or individuals,

- the evaluation of the creditor has been carried out by highly approved international financial houses, such as e.g., Standards & Poor's or Moody's.

3.1.1.2. In the Internal Ratings Based approach-IRB

In the case of using the IRB methodology to calculate the weighted credit risk a bank could implement, as shown in Diagram 1, it is subdivided into two (2) individual approaches: The *Fundamental* and the *Advanced* approach.

These two (2) individual approaches differed in the way of calculating the bank's risk weighted assets (RWA thereafter) and, by extension, the corresponding capital charge. In more detail, both IRB approaches used three (3) parameters to assess the credit risk of the bank's assets: the probability of default (Probability of Default-PD) of the counterparty, the loss in case of default (Loss Given Default-LGD) of the counterparty and the exposure in case of default (Exposure at Default-EAD) to the counterparty. However, in the case that the *Fundamental* approach is applied, the bank could use its own estimates regarding the parameter (PD) but relied on external methods to estimate the other two parameters in the determination of credit risk (i.e., EAD and LGD). On the other hand, in the case of using the *Advanced* approach, the bank could use its own estimates for all three (3) parameters (PD, EAD and LGD) in the calculation of the RWA as well as its capital charge.

3.1.1.3. In Securitization

An important element introduced by the BIS Commission, through this specific edition, was the crucial issue of retaining or not some capital charge in case of banking involvement in securitizations (see Albertazzi, et al., 2011). This operation begins with the sale of some as-

sets of a bank (mainly loans) to a special purpose entity (SPV) which "converts" them into different classified bonds and then makes them available to potential investors. This way, we have a direct money flow from the bank which, as is known, is accompanied by a zero-risk factor. In fact, two (2) main categories of securitization were recognized: *Traditional* and *Synthetic*.[10] In the case that the banks were involved, directly or indirectly, in the purchase of these rated bonds from the securitization, they were obliged to calculate the weighted risk of these bonds to keep the correct proportional charge in their equity (Tier I & II).[11] In addition, as with the simple loans, there were respectively two (2) categories for the evaluation of these rated bonds in the securitization: the *Standardized* and the *IRB* method.

3.2. The calculation of market risk

3.2.1. BCBS, 2006

The market risk here was nothing more than the repetition of the 1996 BCBS edition. However, the calculation of the market risk was now also presented in the denominator of the new capital adequacy ratio [see inequality (2), section 3.4.1].

3.3. The calculation of operational risk

3.3.1. BCBS, 2006

By the term "operational risk" the BCBS (2006) edition referred either to the inefficiency of the bank's internal operations or to external events that negatively affected the bank.[12] As in the case of credit risk, different ways of measuring operational risk were reported. More specifically, we had three (3) methods of approaching operational risk:

- the *Basic Indicator* approach
- the *Standardized* approach
- *Advanced Measurement* approaches.

The BCBS (2006) allowed a bank —provided certain minimum criteria were met— to use the *Basic Indicator* approach for some simple activities and the other two approaches for some more sophisticated activities. Briefly, the *Basic Indicator* approach was a meth-

odology whereby banks held capital at a percentage (e.g., 15%) of the average positive income (gross income) on their Balance Sheet for the last three years of its operation. In the case of the *Standardized* approach, the operational risk was not treated uniformly by the bank with a fixed rate but was based on the subdivision of the bank's activities. The bank would have to subdivide its activities into six (6) sub-sectors and assign a different coefficient to each of them. The sum of these coefficients essentially replaced the total coefficient of the *Basic Index* approach. Additionally, in the calculation of the retained funds in the equity, the cumulative result of the weighted, with a 3-year average, incomes of the individual business activities of the bank were used. Finally, regarding *Advanced Measurement* approaches, recognizing the advanced internal procedures of certain banks, the BIS Commission allowed, under certain conditions, the internal assessment of operational risk using mathematical models, like those that existed in the credit risk calculation.

3.4. The capital adequacy ratio in Basel II

3.4.1. BCBS, 2006

Based on all the above analysis, the new (improved) expression of the minimum capital requirement now had the following algebraic form (CAR):

$$\frac{Tier\ I}{\{Credit\ Risk\} + \{Market\ Risk\} + \{Operational\ Risk\}} \geq 8\% \qquad (2)$$

The inequality (2), which stands as a Capital Adequacy Ratio, like in the case of Basel I, was equal to or greater than 8%. In other words, the supervised capital of the bank should be equal to or greater than 8% of the sum of weighted credit, operational and market risks.

In relation to the existing Basel I commitments, Basel II further specified the following main restrictions:

- Any Tier III capital was fully paid short-term subordinated capital with an initial duration of at least two years without the possibility of early repayment and with a binding condition of non-payment of interest and principal at maturity if such payment would

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10. For a detailed presentation of these two forms of securitization, see Maroulis (2004).

11. When, for example, they participate in the market for rated bonds from a *traditional* securitization or when they used credit derivatives to cover the credit risk position in case of a *synthetic* securitization.

12. Operational risk also includes sections such as legal risk, i.e., effects from various penalties that may be imposed by the central bank, for example.

reduce the bank's capital requirements below the permitted settings by the BIS Committee.

- The ratio of retained capital between Tier I and Tier III should be 28.5% and 71.5%, respectively, for the bank's exposure to market risks.

We proceed below to a very brief presentation of Pillars II and III, which were something new in relation to the Basel I directives and were mainly related to banking supervisory control and market discipline procedures.

3.5. Pillar II (Supervisory Review Process)

3.5.1. BCBS, 2006

The purpose of Pillar II was, firstly, to ensure the managerial capability of the banks and, secondly, to improve the risk management techniques on their portfolios. Through this supervisory review, the BIS Commission intended to develop the best possible cooperation between the central bank and the commercial banks with the aim of taking decisive measures, by the latter, to achieve the most accurate matching of any risk with the equity held by the banks. It was even pointed out that a reduction in any risk was not only linked to quantitative movements. There was always the possibility of better management of the risk by the bank and this could well be attained with a proper supervisory review of the procedures, with the imposition of internal limits and the existence of external controls.

In addition, Pillar II was designed to deal with the problems raised both by risks not already faced by Pillar I (e.g., bank's concentration risk), but also risks not discussed in it (e.g., strategic risk) or other exogenous factors (e.g., effects of economic cycles). Finally, another interesting element highlighted by Pillar II was the evaluation of banks' compliance with the requirements (standards) which the use of *Advanced* risk assessment methods set in Pillar I [such as, e.g., the use of the IRB approach for credit risk and the use of the *Advanced Measurement* methods for operational risk].

3.6. Pillar III (Market Discipline)

3.6.1. BCBS, 2006

The specific section dealt with the necessity, frequency, and quality of the disclosure of data related to banks' capital adequacy. This publication also allowed for a better understanding by the investors of the risks that banks undertake in the framework of "market discipline". As BCBS (2006) explicitly remarks, Pillar III is called upon to play a complementary role vis-à-vis the

capital requirements of Pillar I and as an overview of Pillar II processes.

Regarding the issue of announcing any "sensitive" information, within the framework of Pillar III, the Board of Directors of each bank undertook the responsibility to approve the information to be published. In the framework of Pillar III, extensive information was given by each activity sector of every bank, both in terms of the qualitative and the quantitative part of the notifications that banks should publish.

4. From Basel II to Basel III

The analysis here begins with the basic edition of Basel III (BCBS, 2011) and then proceeds to the more up-to-date editions (BCBS, 2016, 2017, 2018, 2019 & 2021). As in the previous case of Basel I vs. Basel II, the main changes in the calculations of individual risks and their analogous capital requirements are described here.

Before proceeding to a more detailed presentation of the changes brought about in Pillar I of Basel III, it would be useful to mention the reasons why the BIS Commission was led to them. The first was the observed over-leverage on which the financial crisis was "based" in the international banking system (see Papanikolaou & Wolff, 2010); the second was the lack of sufficient liquidity (see Acharya & Mora, 2015) and the third an obvious procyclicality that defined the previous system of credit risk calculations (see Thomadakis & Loizos, 2011). Thus, the adoption of internal risk rating systems, within the framework of Basel II, for the loans of developed banks (e.g., the IRB method), allowed, during the economic boom, the easing of the capital requirements while during the economic recession, allowed some further credit reduction.

As BCBS (2011) explicitly mentions, the purpose of this new revision was:

1. The prevention of excessive cyclicality in capital requirements.

2. The promotion of longer-term forecasts.

3. The creation of a "buffer" of conservation funds in the banking system so that the predicted loses of extreme scenarios by the stress tests could be adequately faced.

4. The achievement of a long-term prudent policy of credit expansion of the banking system in relation to an excessive one.

Thus, regarding the first revision (1), of the excessive cyclicality, the BIS Committee proposed a review of

the use of the probability of default (PD) in the calculation of capital adequacy on a new, less cyclical basis, within the IRB methodology, to achieve a more moderate credit expansion.

Regarding the second revision (2), of the calculation of the promotion of longer-term forecasts, the BIS Committee proposed an improved method to calculate the expected losses (EL) for achieving a shorter possible economic cycle.

On the third revision (3), of the creation of a "buffer" of conservation funds, the BIS Committee proposed the operation of a gradually increasing holding of funds above the known limit of 8% to deal satisfactorily with unexpected adverse events.

In the fourth revision (4), of the long-term restraint of the banking system from an excessive credit expansion, the BIS Committee —as shown in Table 1— proposed the possibility of adjusting the "buffer" of conservation funds based on the progression of the economy. In simple analysis, it was proposed to reduce the "buffer" of conservation funds to a near-zero level in normal economic periods and gradually increase it in a period of excessive credit expansion or in a period of anticipated economic crisis.

4.1 The calculation of credit risk

4.1.1. BCBS, 2011

The general credit risk assessment framework, as detailed in the BCBS (2011) edition, is broadly the same as the BCBS (2006) edition. What changed substantially in the credit asset assessment was mainly related to the review —through the procedures of credit value adjustments [CVA]— of the way the counterparty risk was calculated, both when the banks were able to use the *Internal Models* method (IMM) as much as when this possibility did not exist.

Thus, in the edition of BCBS (2011), the algebraic ways of re-examining credit asset assessment, in terms of the corresponding capital requirement, due to the losses produced from the special categories of complex financial assets, arising from the bank's counterparties, were presented in detail. In fact, if there was no approval for the use of IMM for calculating the risk of the counterpar-

ty, then the bank was compelled to follow a pre-calculated, from an international financial organization, Table with the weighting risk(s) of the counterparty. Another notable differentiation, in relation to Basel II, was a small change in the *Correlation* equation, in the calculation of credit risk (equation (A1), Annex III[13]), when there is a loan exposure of the bank to financial institutions that fulfill some institutional as well as financial conditions. Finally, an additional notable differentiation had to do with redefining the risk of the counterparty [of the bank] through frequent stress tests and scenario analysis to avoid what in the literature is called "wrong-way risk".[14]

4.1.2. BCBS, 2017

The reasons that led to the revision of the BCBS (2011) edition are stated at the beginning of the BCBS (2017) edition. In general, the intent of this revision was to further reduce the volatility of the banks' RWAs as well as to generally enhance the accuracy of risk calculation through the *Standardized* approach for both credit and operational risks. In addition, the BCBS (2017) version limited the possibility of using IRB models[15] in the calculation of credit risk by banks, as it also proceeded to a further review of the method of calculating credit risk due to counterparty risk (credit value adjustments-CVA) by banks.

4.1.2.1. In the Standardized approach

The main feature of the changes in the *Standardized* method of the BCBS (2017) edition, in relation to the *Standardized* method of the BCBS (2006) one, are essentially some changes in the categories of the banks' assets and in their corresponding weighting factors.[16]

4.1.2.2. In the Internal Rating Based approach-IRB

As in the BCBS (2006) edition, there is also a division into two (2) separate approaches: The *Fundamental* and the *Advanced*. In the case of the *Fundamental* approach, there have been a few changes in the assets categories (e.g., there is no such approach anymore for retail banking). In the use of the *Advanced* approach, the algebraic way of valuing the weighted risk

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13. They [banks] should multiply the *Correlation* equation (A1) by a factor of 1.25 to calculate the corresponding capital adequacy.

14. This way a more precise definition of EAD was sought.

15. In the BCBS (2017) edition there is also a review of the weighted capital adequacy ratio, considering the renewed leverage ratio and the new levels of minimum capital.

16. Annex V presents in detail the main changes in the weighted assets categories between the two BCBS editions (2006 and 2017).

of the assets and the corresponding capital adequacy basically remained the same.[17]

4.1.2.3. In credit risk adjustment-CVA

A thorough analysis of credit assessment related to the review of counterparty value calculation (CVA) was carried out in the BCBS (2017) edition. As already mentioned, the counterparty risk is usually linked to market risk factors which can affect the prices of derivatives and of shares that usually constitute the collateral of the bank's counterparty. There are also two (2) approaches to assess the capital adequacy requirements for the credit risk of the banks' counterparty: The *Standardized* and the *Basic*. Banks are encouraged to use the *Basic* approach unless there is approval to use the *Standardized*.

4.2. The calculation of market risk

4.2.1. BCBS, 2016

In the BCBS (2011) edition, we had no major changes in the calculation of market risk. But with the BCBS (2016) edition, there were a few important changes. In more detail, we had:

- the improvement of the *Standardized* approach,
- the improvement of the *Internal Model* approach (IMA),

as well as,

- the change of the *VaR* (Value-at-Risk) approach with the "expected shortfall" (*Expected Shortfall*-ES) approach in case of market risk measurement under financial crisis conditions (Financial Stress Tests),
- the incorporation, in the market risk, of the risk created by the lack of liquidity,
- the reassessment of the limits that separate the trading from the corresponding loan portfolio.

In the first case −the *Standardized* approach− the BCBS (2016) edition states that the methods of assessing the market risk are applied through the sum of three (3) methodologies: the *Sensitivities* method, the *Default Risk Charge* method, and the *Residual Risk Add-on* method. In the second case −of the *Internal*

Model approach− we also have the summation of three (3) individual methodologies, implemented only after the approval by the monetary authorities. These are: the *Expected Deficit* method, the *Bankruptcy Risk* method and the non-modelled *Idiosyncratic Risk Calculation* method applied during a period of crisis (a stressed capital add-on process).

4.2.2. BCBS, 2018

In 2018, the BIS Commission issued a new market risk dedicated edition that brought improvements to the calculation of the *Standardized* approach and the *Internal Models* approach. In the first approach (*Standardized*), the improvements were related to a) the determination of the exchange rates (FX), b) the review of the diversification of the bank's trading portfolio and c) the creation of shock scenarios for the calculation of capital requirement for potential exposure to complex financial assets. In the second case (of the *Internal Models*), additional control procedures appeared such as a) the examination of the performance of the managers regarding the bank's trading portfolio (a PLA test)[18] and b) a better explanation process of how to calculate the non-modelled *Idiosyncratic* risk, especially under financial crisis scenarios.

4.2.3. BCBS, 2019

In 2019, the BIS Commission proceeded again to publish an exclusive edition on market risk. This edition provided some detailed explanations on individual topics of market risk calculation, as a supplement mainly to the BCBS (2016)[19] edition.

4.3. The calculation of operational risk

4.3.2. BCBS, 2017

The BCBS (2017) edition mentions three (3) new methods of approaching operational risk which replaced the existing methods from BCBS (2006). The new methods were:

- the *Business Indicator* (BI) index,
- the *Business Indicator Component* (BIC) index,
- the *Internal Loss Multiplier* (ILM) approach.

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17. See the five (5) equations of Annex III in this regard.

18. Profit and Loss (P&L) attribution test.

19. More specifically, for issues related to the boundaries between the trading and the loan portfolio(s). Additionally, for terminology issues regarding: the market risk, the use of the *Sensitivity* method, the use of the *Residual value* method, and the use of the *Internal Models*.

The *Business Indicator* index is an algebraic equation for operational risk derived from banks' Financial Statements. It contains three (3) sections which involve: the interest rate, the dividend, and the leasing part, as one unit that embraces the operational and the financial procedure of the bank. In the case of the *Business Indicator Component* index, we have an index that is "built" based on the composition of the *Business Indicator* one. More specifically, three (3) different coefficients (%) are assigned to the *Business Indicator Component* index, which change according to the total amount obtained by the *Business Indicator* index[20]. Finally, regarding the *Internal Loss Multiplier* approach, we can state that it is a simple logarithmic function where the derived value triggers the corresponding capital requirement for operational risk. Specifically, the value taken by the *Internal Loss Multiplier* depends mainly on the difference of a Loss index (LC), created from the last ten (10) loss-making financial periods, in terms of the operational risk of the bank minus the value derived from the *Business Indicator Component* index.[21]

4.4. The calculation of capital adequacy[22]

4.4.1. BCBS, 2011

The expression of the minimum capital requirement as algebraically formulated in inequality (2) was unchanged in BCBS (2011). What has essentially changed in relation to Basel II is the intertemporal structure of capital requirements. Table 1 presents in detail these long-term requirements that Basel III incorporated regarding the supervisory capital of banking institutions in relation to their loan portfolios for several years (2013-2019).

Based on the data of Table 1, the gradually increasing relationship between the loan portfolio and the supervisory required capital of the banks becomes evident. The BIS Commission's intention was to contain

TABLE 1 Basel III capital requirements in the banking system

	2013	2014	2015	2016	2017	2018	2019
Minimum common equity capital ratio	3.5%	4.0%	4.5%	4.5%	4.5%	4.5%	4.5%
Capital conservation buffer				0.62%	1.25%	1.87%	2.5%
Minimum common equity plus capital conservation buffer	3.5%	4.0%	4.5%	5.12%	5.75%	6.37%	7.0%
Counter-cyclical activation level of capital conservation buffer				0%-0.62%	0%-1.25%	0%-1.87%	0%-2.5%
Minimum Tier 1 capital	4.5%	5.5%	6.0%	6.0%	6.0%	6.0%	6.0%
Minimum total 1 capital + plus conservation buffer	4.5%	5.5%	6.0%	6.62%	7.25%	7.87%	8.5%
Minimum total capital	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
Minimum total capital + capital conservation buffer	8.0%	8.0%	8.0%	8.62%	9.25%	9.87%	10.5%

Source: BCBS (2011).

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20. For example, for banking operations up to €1 billion the BIC coefficient is 12%. For an amount from €1 billion to €30 billion, the BIC coefficient becomes 15%, while from €30 billion and above, the BIC coefficient becomes 18%. So, if the BI index is, e.g., €35 billion, then the BIC index will be: 1 billion € ×12% + (30-1) billion € ×12% + (35-30) billion € ×18% = 5.37 billion €.

21. For example, when BIC= LC then ILM=1 as well as when BIC<LC then ILM>1 and vice versa. By extension, the more BIC<LC, the greater the requirement in the banks' equity capital for operational risk, and the more BIC>LC, the smaller this requirement becomes. In fact, as reported by BCBS (2017), the minimum operational risk capital requirement (ORC) of a bank is the product of the BIC ratio times the ILM (i.e. ORC=BIC×ILM).

22. For a detailed presentation of the changes and functioning of capital adequacy from Basel II to III, see Kalfaoglou (2012).

the recorded credit expansion of commercial banks internationally. In particular, the existence of a "capital conservation buffer" was an attempt by the monetary authorities to ensure —as best as possible— the avoidance of any financial crisis like that of August 2007. Additionally, for the very important international (G-SIBs) but also national (D-SIBs) banks, an upward change in loss provisions was proposed for reasons of further capital security (see Jones & Zeitz, 2017).

In more detail, the "capital conservation buffer" of 2.5%, on top of the "minimum common equity capital ratio" of 4.5%, was activated not by the establishment of losses in the bank in question, but in the stage of the capital distribution of its profits. In fact, in Table 2 below, the BCBS (2011) edition described the ways in which the bank's capital would be distributed according to the level of its capital adequacy. So, for example, a bank with a Tier 1 Ratio (CET1) at the levels between 5.12% to 5.75% was now obliged to "keep" 80% of its profits in the bank for the following years and "distribute" the remaining 20% in the form of dividends, shares, or bonuses. Accordingly, if it had CET1 at the levels between 6.37% to 7.0%, it was obliged to "keep" 40% of its profits in the bank for the following years and "distribute" the remaining 60%, etc.

In addition, the BCBS (2011) edition recognized the importance of the economic cycle and the consequences it brings to the credit expansion of banks. For this reason, it created a "countercyclical buffer" so that the capital adequacy of the banks consider the macro-financial environment in which the banks operate. According to the BCBS (2011), this "countercyclical buffer" would be calculated based on the following Tier 1 ratio (CET1) data:

a) The national authorities (e.g., the central banks) of each country would have to monitor the increase in credit expansion and judge accordingly whether it was excessive behaviour and were authorized therefore to activate the buffer. Its de-activation would be judged accordingly.

b) Banks with a multinational activity should consider the geographical environment in which they operate and calculate the "countercyclical buffer" as a weighted average of the individual buffers in the countries they operate.

c) The derived obligations of the particular "countercyclical buffer" for each bank would determine the size of the buffer accordingly. This consequently would also affect the amount of dividend that the bank could distribute later.

In the same edition (BCBS, 2011), the leverage ratio (LR) was presented, for the first time, which could be considered as a complementary part of what we call banks' capital adequacy. This leverage ratio had the following algebraic form:

$$LR = \frac{(Capital\ measure)}{(Exposure\ measure)} \geq 3\% \qquad (3)$$

In more detail, the numerator of the fraction of inequality (3) ("capital measure") consisted of Tier I funds (e.g., common shares). On the other hand, the denominator ("exposure measure") mainly includes Balance Sheet items, derivative products and shares that finance (or hedge) any purchases and sales of the bank as well as any off-Balance Sheet items which, however, are not weighted for risk.

4.4.2. BCBS, 2017

In this edition, a capital "output floor" appeared, below which banks should not fall in terms of their CAR. But

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TABLE 2 Banks' minimum capital levels

Common Equity - Tier 1 ratio (CET1)	Minimum capital conservation ratios
4.5% - 5.125%	100%
>5.125% - 5.75%	80%
>5.75% - 6.375%	60%
>6.375% - 7.0%	40%
> 7.0%	0%

Source: BCBS (2011).

there were also some additional restrictions that had to be "satisfied" immediately. More specifically:

- The total amount of Tier I common stock should be at least 4.5% of the sum of the weighted assets in any case.

- The sum of Tier I elements should be at least 6% of the sum of the weighted assets in each case.

- The total capital (Tier I + Tier II) should be at least 8% of the sum of the weighted assets in any case.

In fact, the BCBS (2017) edition formulated an example of how to calculate the capital adequacy of a bank by comparing its total weighted risk before the imposition of a capital "output floor" and after it. It proposed the selection of the higher value of the two alternative results for the calculation of capital adequacy. For example, BCBS (2017) compared the required funds in the case the bank's weighted assets calculated differently (through either the *Independent*, the *Standardized* or the *Internal* method), taking into consideration that the result of the *Standardized* method times 75% represents the capital "output floor". The bank is obliged to use the higher value of the two results for the calculation of its capital adequacy. In the calculation of these two alternative cases, all types of risk should be incorporated (e.g., credit, securitization, credit adjustment, market, and operational risk). It also pointed out that the application of the above method for calculating the capital "output floor" would start from January 1, 2022, with a multiplication of 50% of the *Standardized* method and would gradually reach full application, with 75% of the *Standardized* method, on January 1, 2027.

4.4.3. BCBS, 2021

In the 2021 edition, which was published by the BIS Commission intending some further explanations on capital adequacy measurement (e.g., regarding the minimum common equity capital ratio and the gradual increase of 2.5% due to the "countercyclical conservation buffer"), the main Tables basically remained as they were in 2011, with some small changes.

5. The theoretical presentation of the liquidity channel in Basel III

In addition to all these changes, in terms of capital adequacy, Basel III —as an institutional framework— also focused on the importance of avoiding any liquid-

ity crisis that could endanger the banking system. In macroeconomic terms, we refer to the existence of a liquidity channel. The specific channel is essentially connected to the bank's Balance Sheet and in more detail to the two (2) main elements of the structure of the bank's Balance Sheet: a) the different maturity time (maturity mismatch) between the assets and liabilities and b) with a potentially high degree of leverage in the banking system.

More analytically, it has been observed that many problems in the history of the banking system of various countries started either from over-leveraging assets or from a highly different level of maturity (maturity mismatch) between their assets and liabilities. The result of such extreme situations could be a liquidity shock, which could lead to a "bank run". In fact, as pointed out by the BCBS (2011) edition, in such financial situations, banks sell their assets, resulting in a further decline in their Balance Sheets and exacerbating the problem. Diamond & Dybvig (1983) were the authors who initially highlighted the mechanism as well as the liquidity shock, and Diamond & Rajan (2005) revealed the interconnection between liquidity shocks and the risk of an immediate bank failure. In fact, the latter two authors explained in detail in their article how a withdrawal of deposits from customers or a refusal to recycle the bank's debt to its customers can lead to an "aggressive" liquidation of otherwise profitable loans. This can lead to a fall in expected bank profits with serious further implications for the bank's future creditworthiness and survival (solvency).

Based on the above theoretical analysis, in the relevant banking literature, the need to immediately deal with such a form of liquidity crisis was revealed. In fact, two forms of liquidity problems were identified: one was related to the bank's ability to immediately find ways, through the sale of its assets, to repay the obligations which are derived from its liabilities (funding liquidity), and the other to a bank's ability to buy and sell its assets in the market (market liquidity). In fact, as mentioned by BCBS (2011), these two forms of liquidity risk could, under certain conditions, be interrelated and lead to an increase in the banks' credit risk.[23]

5.1. The introduction of liquidity rules in the banking system

Based on the risks of an immediate bank failure, which could come from a liquidity shock, the BIS Commission proceeded with a series of rules to strengthen the

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23. See also Allen & Gale (2008); Brusco & Castiglionesi (2007); Strahan (2008), etc.

liquidity position of financial institutions. This question was introduced after the 2007 financial crisis, when many international banks found themselves with serious liquidity problems due to imprudent management from their managers.

Specifically, according to the BCBS (2013) and BCBS (2014) editions, two (2) additional ratios were defined which would control the liquidity of the banking system: the liquidity covered ratio (LCR) and the net stable funding ratio (NSFR), respectively.

Starting from the first ratio of the covered liquidity (LCR), we can briefly mention that it had the following algebraic form:

$$LCR = \frac{HQLA}{NCOR} =$$

$$= \frac{High\ Quality\ Liquid\ Assets}{Outflows - min(Inflows,\ 0.75 \times Outflows)} \geq 100\% \quad (4)$$

By the term "high-quality liquid assets", in the numerator of the inequality (4), the BIS Commission was referring mainly to cash, high-quality stocks and government bonds. All these items were considered immediately liquidable. On the other hand, the denominator essentially referred to net total bank outflows of 30 calendar days. Both outflows and inflows mainly had to do with immediately enforceable payments or collections (cash outflows and inflows) within a maximum period of 30 days.

The specific ratio was gradually implemented for the banking system. Specifically, the beginning of the international application was January 2015 at a level of 60% and then followed a progressive implementation up to 100% in 2019. Table 3 below shows us the time and quantitative process of implementation of the ratio by the banks, internationally.

The purpose of the ratio was to push banks to adopt a portfolio that would be able to be financed more easily, especially in critical periods. More specifically, a portfolio with significant exposure to low-risk and easily liquidable stocks or bonds, but also with only a few short-term loans. For the structure of bank liabilities, the BIS Commission recommended that banks rely less on deposits from the market and more on retail (banking) and non-financial corporations.

As for the second ratio, the net stable funding ratio (NSFR), it had the following algebraic form:

$$NSFR = \frac{Liabilities}{Assets} = \frac{Available\ Stable\ Funding\ (ASF)}{Required\ Stable\ Funding\ (RSF)} \geq 100\% \quad (5)$$

Regarding the numerator of the ratio (Available Stable Funding-ASF), we can mention that it included several elements of the liabilities which, as mentioned by the BCBS (2014), were classified as elements of ASF. For example, a 100% element of ASF was considered the (equity) capital plus the liabilities with a maturity of more than one year. Deposits with a maturity of less than one year were considered as 90-95% ASF elements, which mainly originated from retail but also from SMEs. Deposits with a maturity of less than one year, which mainly originated from financial companies or operational deposits, e.g., public organizations, or multinational banks, etc., were considered as 50% ASF elements. Finally, the deposits of other central banks or financial institutions with a maturity of less than 6 months or deposits without a clear maturity or also derivative differences —especially if this difference was negative (loss) for the bank— were considered as 0% elements of the ASF. Table I4, in Annex I, is very analytical in the categorization of the liability items with the corresponding percentages of the ASF.

On the other hand, the denominator of the ratio (Required Stable Funding-RSF) included all elements of the asset side which, in a banking system, were considered as less liquid during a financial crisis. According to the BCBS (2014) edition, there is also a rating concerning the assets elements. Table I5, in Annex I,

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TABLE 3 Minimum level and implementation time of banks' liquidity covered ratio (LCR)

	1/1/2015	1/1/2016	1/1/2017	1/1/2018	1/1/2019
LCR	60%	70%	80%	90%	100%

Source: BCBS (2013).

is analytical in the categorization of the assets with the corresponding percentages of the RSF.

6. Conclusions

The establishment and evolution of the different BCBS editions by the BIS Committee was an important improvement of the regulatory conditions on which the stability and orderly operation of any developed banking system is based. The aim was, if not to avoid, at least to minimize the effects of any economic crises on it. In this article, the most important changes were highlighted, from 1988 to recently (2021), regarding the capital requirements, as well as the analytical delimitation of the weighted elements of the credit, operational and the market risk for the banks. In addition, the relatively more recent liquidity restrictions introduced by the BIS Commission (Basel III) were presented to address any liquidity risk that banks may need to face in an increasingly internationalized environment.

The answer to the question of whether these changes are sufficient for the stability of a banking system is not easy. In our opinion, the successful implementation of the rules of the BIS Committee is also linked to other factors such as the (political) power of the big banks, the different legal and political obstacles for the implementation of the directives, the level of development of the financial infrastructure of each country, the high quality of specialized staff and the existence of abundant data (see Jones & Zeitz, 2017), and finally the great advantage of the exclusive legal ability of banks to create credit *ex nihilo* (see Werner, 2014). Therefore, in a heterogeneous international banking system, the scale of the successful implementation of all these BIS Commission directives is rather limited for an effective long-term stability of the banking system.

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ANNEX I

TABLE I1 Bank's Risk Weighted Assets (RWA)

Risk Weighted Asset (RWA) 0%:	(a) Cash,
	(b) Claims from a central bank,
	(c) Other claims from OECD central governments and other central banks,
	(d) Claims secured by government cash or OECD government bonds.
Risk Weighted Asset (RWA) 0%, 10%, 20% or 50% (by national choice):	(a) Claims from public sector organizations other than the central government, and loans guaranteed by such organizations,
	(b) Claims from international development banks and other claims which have been guaranteed by shares of such banks,
	(c) Claims from international OECD banks and loans from OECD banks as well as loans guaranteed by OECD countries. Claims from banks outside the OECD list but with a final maturity of up to one year,
	(d) Claims from public sector organizations outside the OECD list and outside the central government, and loans guaranteed by such organizations,
	(e) Cash in process of collection.
Risk Weighted Asset (RWA) 50%:	Loans fully covered by real estate.
Risk Weighted Asset (RWA) 100%:	(a) Claims from the private sector,
	(b) Claims from non-OECD banks with a maturity of more than one year,
	(c) Claims from non-OECD central governments (unless denominated in domestic currency),
	(d) Claims from commercial companies that belong to the public sector,
	(e) Plant, tools, and other fixed assets,
	(f) Real estate and other investments (including holdings in other companies),
	(g) Holdings in other banks,
	(h) All other assets of the Balance-Sheet.

Source: BCBS (1988).

TABLE I2 Banks' off-Balance Sheet Risk Weighted Assets (RWA)

Risk Weighted Asset (RWA) 0%:	Loan commitments with an initial maturity of up to one year, which can be cancelled unconditionally at any time.
Risk Weighted Asset (RWA) 20%:	Short-term trade-related liquidity problems (guaranteed by the commodity itself).
Risk Weighted Asset (RWA) 50%:	(a) Specific transaction-related data (e.g., yield bonds, offering bonds, guarantees and fallback letters of credit related to specific transactions),
	(b) Facilities for issuing credit notes and other rolling underwriting facilities,
	(c) Other credit commitments (e.g., standard facilities and credit lines) with a maturity of more than one year,
Risk Weighted Asset (RWA) 100%:	(a) Direct credit substitutes, e.g., general debt guarantees (including letters of credit serving as financial guarantees for loans) and acceptances (including entries with characteristics of acceptance),
	(b) Sale and repurchase agreements on assets and sales of assets where credit risk remains with the bank,
	(c) Forward purchases of assets, forward-forward deposits and partially paid-up shares and securities representing commitments with a fixed drawdown.

Source: BCBS (1988).

TABLE I3 Exposure factors on the residual value of the financial products of the trading portfolio*

Residual value (X)	Interest rates (%)	Exchange rates (%)	Gold (%)	Commodities (%)	Equities (%)
χ ≤ 1 year	0	1.0	6.0	7.0	10.0
1 year ≤ χ ≤ 5 years	0.5	5.0	8.0	7.0	12.0
χ ≥ 5 years	1.5	7.5	10.0	8.0	15.0

Source: BCBS (1998).

* The bank's exposure to these financial instruments typically involved derivative contracts on these instruments (e.g., Swaps, Futures, Options, etc.).

TABLE I4 Liabilities classification in relation to ASF (Main)

(%) ASF	Liabilities
100%	• Total share capital, and
	• Other capital items and liabilities with a maturity of more than 1 year.
95%	• Stable deposits with a residual maturity of less than one year, mainly from retail but also from SMEs.
90%	• Less stable deposits with a residual maturity of less than one year, mainly from retail but also from SMEs.
50%	• Financing with a residual maturity of less than one year provided by non-financial corporations.
	• Operating deposits.
	• Financing with a residual maturity between six months and one year, e.g., by central banks, etc.
0%	• Other balance sheet liabilities, e.g., without clear maturity.
	• Derivatives differences – especially if this difference is negative for the bank.

Source: BCBS (2014).

TABLE I5 Assets classification in relation to RSF (main)

(%) ASF	Assets
0%	• Coins and banknotes.
	• Central bank reserves (e.g., required reserves as well as excess reserves).
	• Unencumbered loans to banks with a residual maturity of less than six months.
5%	• Negotiable securities representing states, central banks, or other well-known institutions (e.g., ECB, IMF, BIS, etc.) that have zero credit risk under Basel II.
	• Government debt or non-zero risk-weighted central bank debt.
15%	• Negotiable securities representing states, central banks, or other well-known institutions (e.g., ECB, IMF, BIS, etc.) that have 20% Basel II credit risk.
	• Corporate debt or covered bonds which are rated at an AA- level of credit risk.
50%	• Real estate securities (RMBS) with a rated credit risk of at least an AA level.
	• Corporate debt with rated credit risk between A+ and BBB-.
	• All loans to banks with a residual maturity between six months and one year.
	• Deposits, for operational purposes, with other financial institutions.
	• Other assets not included in the above categories and have a residual maturity of less than one year.
65%	• Unencumbered real estate loans with a residual maturity of more than one year with less than 35% credit risk under Basel II.
	• Other unencumbered loans not falling into any of the above categories, excluding loans to financial institutions with a residual maturity of more than one year with a credit risk of less than 35% under Basel II.
85%	• Other unencumbered loans with a residual maturity of more than one year and no less than 35% credit risk under Basel II,
	• Other unencumbered securities that are not in default and do not belong to highly liquid assets (HQLA).
	• Gold and other traded commodities.
100%	• All encumbered assets with a maturity of more than one year.
	• Derivatives differences, especially if this difference is negative (loss) for the bank,.
	• All assets not reported in the above categories.

Source: BCBS (2014).

ANNEX II

The calculation of the residual value, based on the data of Table I3-Annex I, plus the *replacement costs* from the "closing" of the financial product contracts added up to a total amount that constituted the capital charge of the bank for a range of financial products (*market risk*). In algebraic form, this risk, as an amount, E^{MR}, was calculated using the following equation:

$$E^{MR} = RC + \text{"add on"} \quad (1)$$

with $\quad \text{"add on"} = X(\%) \times P^N \quad (1a)$

where: E^{MR} is the bank's total exposure, as an amount, from the contracts of these financial products; RC is the cost of "closing" the financial position or *the cost* of replacing the financial contracts by the bank (it could also be a profit); X is the risk of variation in the residual value of the financial product up to its maturity, calculated as a percentage (%) in Table I3; P^N is the nominal price (value) of the financial contract, which is the future exposure of the bank to these financial contracts.

ANNEX III

The original mathematical system of equations for calculating credit risk in the IPB method had the following form:

$$\text{Correlation } (R) = 0.12 \times \frac{1 - e^{-50 \times PD}}{1 - e^{-50}} + 0.24 \times$$
$$\times \left(1 - \frac{1 - e^{-50 \times PD}}{1 - e^{-50}}\right) \quad (A1)$$

$$\text{Maturity adjustment}^1 (b) =$$
$$= \left(P_a - P_b \times Ln(PD)^2\right) \quad (A2)$$

$$\text{Capital requirements } (K)^2 \text{ (as \%)} =$$

$$= \left(LGD \times N\left(\frac{G(PD)}{(1-R)^{0.5}} + \left(\frac{R}{(1-R)}\right)^{0.5} \times G(0.999)\right) - \quad (A3)$$
$$-PD \times LGD\right) \times \frac{1 + (M - 2.5) \times b}{1 - 1.5 \times b}$$

$$\text{Risk-weighted elements}$$
$$(RWA\text{: as an amount}) = K \times 12.5 \times EAD \quad (A4)$$

$$\text{Capital charge}^3 = 8\% \times \left(RWA \text{ (as an amount)}\right) \quad (A5)$$

Where: $N_{(x)}$ refers to the cumulative distribution function of a standardized normal random variable. In other words, the probability of a normal random variable, with mean 0 and variance 1, to be less or equal to x, and

$G_{(z)}$ refers to the inverse cumulative distribution function of a standard normal random variable, i.e., the value of x so that $N_{(x)} = z$.

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1. In the parameters (P_a & P_b) of this equation numerical values are usually given after some simulations.

2. If the "capital requirements (K)" go negative, e.g., in the case of a reliable bond, then zero is chosen.

3. The capital charge in the *Standardized* approach can be considered as a limited *IRB*. In particular, the *Standardized* approach does not include any *PD* (or as if *PD* = 100% or 1). So, in this approach, we speak for expected losses (EL) held in Tier's. Algebraically speaking, we keep only equations (A4) and (A5), since with *PD* = 1 or 100%. This happens because equation (A1) is $R = 0.12$, equation (A2) is $b = P_a^2$ (constant) while equation (A3) $\cong 0$ (is of no use).

ANNEX IV

There are five (5) risk-weighted risk (*RWA*) categories that Basel II provided for calculating the unexpected losses (ULs) from banks' assets (future claims).

TABLE IV.1 *Risk Weighted Assets (RWA)* to calculate unexpected losses (UL) on corporate, banking and sovereign risk

Category	Strong	Good	Satisfactory	Weak	Default
External evaluation	BBB- or better	BB+ to BB	BB- to B+	B to C-	NA
Risk Weighted Asset- (%)	70%	90%	115%	250%	0%

Source: BCBS (2006).

TABLE IV.2 Long-term calculation of securitisation bonds

External evaluation	AAA or AA-	BB+ to BB	BB- to B+	B to C-	B+ and smaller, or Unclassified
Risk Weighted Asset- (RWA)	20%	50%	100%	350%	Subtraction from Tiers

Source: BCBS (2006).

TABLE IV.3 Short-term calculation of securitisation bonds

External evaluation	A-1/P-1	A-2/P-2	A-3/P-3	Not available
Risk Weighted Asset - (RWA)	20%	50%	350%	Subtraction from Tiers

Source: BCBS (2006).

The main changes in the BCBS (2017) edition categories [Basel III] compared to the corresponding BCBS (2006) edition categories [Basel II] were:

- International Development banks

A new separate category in the BCBS (2017) edition with the following ratings: AAA to AA- (20%), A+ to A- (30%), BBB+ to BBB- (50%), BB+ to B- (100%), below B- (150%) and finally ungraded (50%).

- Exposure to (other) banks

An existing category of the BCBS (2006) edition, which was now differentiated into "basic" and "short-term". Both categories now were at roughly the same weighting levels of the BCBS (2006) edition. The only substantial weighting factor change was in the rating, between A+ to A-, of the "basic" category (from 50% to 20% in 2017). There was also no longer an unrated weighting in either category.

- Exposure to shares of companies and other financial institutions

A category which, according to the BCBS (2017) edition, resembled exposure to banks if supervisors followed strict supervisory procedures as in the case of banks.

- Exposure to companies

A new category which included, according to the BCBS (2017) edition, insurance and other financial corporations that did not meet the classic definition of a bank. There were two weighting factor changes compared to the corresponding category of the BCBS (2006) edi-

tion: The rating from BBB+ to BBB- increased to 100% (from 75%), and we had an added-up category (BB+ to BB-, with 100% weighting factor) that did not exist in the BCBS (2006) edition.

- Exposure to retail banking

According to the BCBS (2017) edition, this category incorporated three (3) main sub-categories: the "simple" retail with a weighting factor of 75%, the "simple" retail associated with timely repayments (e.g., credit cards) with a weighting factor of 45%, and, finally, the "others" that did not meet certain criteria with a weighting factor of 100%. In the BCBS (2006), edition we had only one category with 75%.

- Exposure guaranteed with real estate

In the case of the BCBS (2017) edition, a ratio was created as the value of the loan to the value of the asset operating as collateral (LTV - Loan to Property ratio). The higher this ratio was, the higher the weighting factor assigned to the bank's report. In addition, and in contrast to the BCBS (2006) edition, in the two (2) real estate sub-categories —the residential and the commercial— a series of respective weighting factors were assigned. In the case of the BCBS (2006) edition, we had only a percentage for each sub-category that was not physically correlated with the LTV ratio.

- Exposure to off-Balance Sheet items

In this case, according to the BCBS (2017) edition, some new categories were created, and a different weighting factor was assigned.

The core, supplementary, and additional supplementary funds (Tier I, II & III) on a more detailed basis were as follows:

The core Capital (Tier I)

As recorded in the BCBS (1988), Tier I funds were sub-divided into *paid-in share capital* and *reserves*. In the BCBS (1998) edition, in the context of Basel I, in the *paid-in share capital,* both the *ordinary* and the *preference shares* were included as well as the *Reserves*. Several other elements of the accounting system are enclosed within these *Reserves* (see Table VI.1).

More specifically, retained *gains or losses* appeared, which constitute the accumulated annual profit and loss of the bank that are transferred to its own funds. However, other forms of capital (*surplus*) are also presented as, for example, some new capital created either by a listing of the bank's shares on the stock exchange (IPO–*initial public offering*), or by another form of share *premium account* (of the nominal value), or from *general retained reserves* (e.g., tax-free reserves for investment purposes or reserves formed by the bank's statutory obligations such as the statutory reserve, etc.). In the case of a bank's consolidat-

ed accounts, Tier I also includes *minority interests* that constitute the participation of other interest group(s) in the share capital of the bank's subsidiaries.

Supplementary funds (Tier II)

The supplementary funds are those which, according to Basel I (1988 & 1998), could support "losses" without creating serious liquidity problems for the bank. In other words, their aim was to help the bank to "finance" its assets in a less suffocating way than that of Tier I.

At the beginning of the whole process, the BIS Committee allowed only Tier I elements to finance and control the activities of banks. This permitted only a few banks to be able to cope with such a "credit corset". So, thanks to Tier II funds, which were a mixture of "other" equity elements and some bank liabilities (with characteristics, in terms of maturity & repayment, analogous to equity), a looser credit control on banking activities was granted.

Regarding the individual components of Tier II (see Table VI.2), starting with *undisclosed reserves*, we could say that these funds are considered eligible after approval by the supervisory authorities. Theoretically, this determination corresponds to a portion of the after-tax profit or loss accounting results. Indeed, banks' supervisors expect such a "buffer" to assist banks to deal with contingencies losses.

The *revaluations of assets* are also included. Regarding banks' fixed assets, in some countries there is the option of revaluing them and presenting any existing difference in their equity. In addition, the option of exhibiting the results from revaluations of banks' portfolios and the re-estimation of shares which appear in their historical acquisition costs in the Balance Sheet is also granted. Basel I offered the possibility of a discount of 55%, in terms of the difference between historical cost and current market price of e.g., a share in the trade portfolio, not only in order to protect the bank from strong market fluctuations in the share prices (volatility), but also for reasons of tax charging on unrealized gain in the equity.

There were also the *General reserves to cover unexpected defaults by counterparties*. This case refers to the need for capital to cover the bank against possible defaults on loans by counterparties that had not yet been specified. In addition, Basel I made it clear that the bank should not cover already recorded losses with these *reserves*. Finally, the amount of general reserves should not exceed 1.25% of the bank's total risk weighted asset requirements.

Hybrid capital tools also appear. With this term, Basel I referred to a series of supervisory "policy tools" that encompass both equity and debt characteristics. These "policy tools" can be preferred shares, convertible bonds, and perpetual loans. The exact concept of *hybrid capital tools* varied from country to country but, as stated in Basel I (BCBS, 1988 & 1998), there were certain conditions that had to be generally convened by these funds to be included in Tier II.

The *Unsecured Debt*, as a debt instrument, although part of the bank's liabilities, is also included in Tier II. This additional type of capital must have a lifespan of

more than five years. It also contained the time-limited redeemable preference shares (which are not related to those of Tier I). These shares were offered at a discount of 20% per annum by banks, which also indicated their limited value as a capital tool. Finally, it should be noted that these funds differed from *hybrid capital tools* because they did not participate in the bank's losses.

Some further supplementary funds (Tier III)

These additional funds (Tier III) displayed by the BCBS (1996) edition were a short-term subordinated debt that operates in the bank's equity in cases related to market risk. The aim was to become part of the bank's permanent capital so that it could absorb losses in the event of bankruptcy (insolvency). However, to be able to have this status, these funds should, as a minimum:

- be non-guaranteed, subordinated and fully paid-up,

- have an initial duration of at least two years,

- be not repayable before the agreed repayment date, unless agreed by the supervisory authority,

- be subject to a lock-in clause stipulating that neither interest nor principal could be paid (even at maturity) if such payment would lead the bank to fall below or generally be below its minimum capital requirement.