

Quantitative Analysis of the Impact of Basel II Accord on Greek Banks: The Application of IRB Approach

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Abstract

In this paper, after conducting a series of alternative scenarios for various factors, we examine the implementation of Basel II capital adequacy rules on Greek Banks, according to the Internal Rating Based Approach (IRB), introduced by Basel II Accord. The IRB approach allows the development and use of models measuring the three main risks (credit, market, and operational). However, up to now, the researches that have been examined these risks for Greek Banks are very limited, and the impact of adverse events on the loan portfolio of the Greek Banking System has not yet been satisfactorily evaluated. In this empirical study, the Greek Banks are clustered into three separate groups, in particularly large, medium, and small size. The model formed provides information for supervisory reasons as for the level of capital maintained, depending on the nature of activities and risks taken by a Bank. The results show that the IRB approach is more appropriate for larger Banks, which can invest in risk management and maximize profit to risk ratios. For Banks with lower capital, this methodology could entail high risks. From the study, it was, also observed that retail portfolios and mortgage portfolios are favored due to credit risk, a benefit that is attributed to risk dispersion and collaterals (mortgages).

Keywords

Basel Accords, Capital Requirements, Credit Risk, Banking Supervision, IRB Approach

1. Introduction

The Basel Committee has set a comprehensive internationally uniform prudential set of regulatory standards for the bank's capital, aiming to strengthen

supervision and risk management framework of banking sector at global level. Based on Basel I and II Accords, Banks are required to hold an appropriate level of owner's equity to deal adequately risk exposures (Basel Committee on Banking Supervision, 1988, 1999, 2000, 2001a, 2001b, 2003a, 2004, 2006a; Hendricks & Hirtle, 1997; Bank of Greece, 1999; Santos, 2000; Alexander & Sheedy, 2004).

Basel I defines the minimum (8%) capital requirements (capital to risk weighted assets (RWA)) that Banks are obliged to keep. The calculation of risks is based on supervision flat coefficients set by the Basel Committee, without taking into account credit risk mitigation techniques (i.e. collaterals or/and guarantees). Specifically, a portfolio approach is taken to measure credit risk. Assets are classified into four buckets (0%, 20%, 50% and 100%) according to the debtor category. The framework of Basel I appeared to be weak in measuring precisely underlying risks that occurred by market growth of new product development and new activities, as well to address the additional regulatory capital requirements. Thus, the Basel Committee developed a more risk-advanced framework. Basel 2 consists of a more sensitive approach that promotes in a more specific and sophisticated way risk management and measurement of credit and market risk, through the use of models and formal techniques, including qualitative and quantitative criteria in measuring risks.

Basel II is a more risk sensitive approach to Basel I. In this respect Basel II penalizes bad portfolios, or rewards good portfolios much more effectively than Basel I (Jones & Mingo, 1999; Crouhy et al., 2000; Jackson, 2002). The Capital Adequacy Framework (Basel II) proposes a significant refinement of regulatory and supervisory practice and encourages increased attention to risk management practices in supervisory financial institutions and improved disclosure and market discipline (Basel Committee on Banking Supervision, 2000, 2001a, 2001b, 2003a, 2004, 2006a; Ayadi & Resti, 2004; Ozdemir & Miu, 2009). It is noted that in the first Basel Accord, the risks taken into account were credit risk and market risk, while in the second Basel Accord the operational risk is also included.

Basel I suggests the use of the standardized (ST) approach and Basel II suggests the use of the ST approach and the Internal Rating Based (IRB) approach (Basel Committee on Banking Supervision, 2004; Ayadi & Resti, 2004). The application of ST approach of Basel II presents similarities with the respective approach of Basel I (calculation of risks based on supervision coefficients). Still it intends a more risk sensitive framework for the calculation of Banks' capital requirements, including additional factors for calculating the total results (delinquencies, collaterals, credit ratings, etc.). The second approach (IRB approach) of Basel II allows the development and use of models measuring the three risks. One must expect that the application of the IRB approach represent more reliable economic effects after conducting a series of alternative scenarios for various factors (Ozdemir & Miu, 2009).

Several quantitative impact studies (QIS) were conducted by the Committee since the launch of the Basel framework to better understand the relevant effects

on capital requirements for European Union Institutions ([Basel Committee on Banking Supervision, 2001c, 2002, 2003b, 2005, 2006b](#)). Indeed, several European Banks took part in adverse situations that studies stimulate to assess capital requirements reductions depend the type of approach used, composition and quality of the portfolio, risk management strategies and create a framework of preventive supervision of credit institutions. In the first three first impact studies, none of the Greek Banks did participate. Based on QIS results of the other studies were Greek Banks participated, they used the ST approach and note an increase of capital charges mainly due to operational risk. Also, there have been several works published, which examine issues related to dealing with, or avoiding, adverse situations ([Hellenic Parliament, 2013](#); [Foglia, 2009](#); [Haldane, 2009](#); [Leventides & Donatou, 2015](#); [Donatou & Leventides, 2020](#)).

However, up to now, the effects that will be brought upon the capital requirements of the Greek banking system, the reserved capital for hedging the risks undertaken that have been calculated by the adoption of more advanced methods (IRB) have not been fully addressed. Furthermore, to adopt more advanced methods a Bank should demonstrate compliance with the minimum regulatory requirements (i.e. rating system design with reasonably accurate and consistent quantitative estimates of risk, validation of internal estimates, collateral recognition/allocation etc.). Important issues as which category of Banks will be more affected, which parts of portfolios will have the greatest, as to their seize and extent, changes, what will be the degree of impact etc., do not have the necessary qualitative corroboration. The less information a Bank has, the more conservative must be.

The paper examines the impact from the implementation of Basel II on Greek Banks, through the evolution of the proposed risk assessment IRB approach of Basel II. In this view, we used parameters for both non-defaulted and defaulted exposures on 18 Greek Banks, account for over 80% of Greek Banks' total credit risk-weighted exposures, in order to assess the impact of IRB and the treatment of non-defaulted and defaulted exposures. Mainly, it is aimed to analyze the main implication of Basel II, based on risk sensitiveness due to credit risk in Greek Banking System and to assess their effect per portfolio and per Bank in order to evaluate capital changes and measure credit risk exposure.

2. Data and Model Development

In the empirical study conducted, taking into account the requirements laid out by the second Basel Accord in combination with the principles that the international accounting standards pose and the operational structure of Greek Banks, it was considered that it is particularly important to create a model that will be in a position to estimate credit risk based on the supervision framework. During the development of the model, it was taken into account that each Bank is characterized by particularities which concern the type and range of its functions, the Bank risks taken, and the efficiency of the policy that sets the amount of de-

manded equity capital, which requires specialized investigation and evaluation. The development of the model is based on the application of the procedures and approaches introduced by the two existing accords and analysis of the total level of supervisory and economic capital.

The study analyses, for alternative conditions, the effect of the Basel II accord on 18 Greek Banks that are active in Greece, listed in the Greek stock market and supervised by the Central Bank of Greece. We also took into account a set of banking regulations put forth by the Basel Committee, International Accounting Standards (IAS) principles that guides and standardizes accounting practices and the operational structure of Greek Banks.

Table 1 displays all financial data for the three Banks (Bank 1, Bank 2 and Bank 3).

For our empirical analysis, we used a database containing financial data from the major percentage of Greek commercial Banks (80%). The database contains all loan files that the Banks maintains for current and overdue loans for each asset class, provisions, parameters values which Basel accords and, hence, Bank of Greece imposes for estimating the credit and operational risk in order to calculate their capital adequacy. Moreover, the model accepts data per asset class (types of loans), product type, risk category, type of collateral, etc. Balance sheets, annual reports, and regulatory reports provide the data that are used in the model. The application of the methodology developed by [Hartigan \(1975\)](#) and [Bartholomew \(2002\)](#) led us to the evaluation of three “representative Banks”, each of one forms a “synthesis” of three categories of Banks (larger (Bank 1), medium (Bank 2) small (Bank 3)). Data were reported on aggregate basis, in order to guarantee the anonymity and confidentiality of credit institutions.

Table 1. Basic indicators analysis by bank.

	Banks	Bank 1	Bank 2	Bank 3
	Assets (in EUR)	235.713.397.000	76.312.377.172	24.824.817.920
	Capital (α EUR)	16.907.423.000	381.616.4278	2.149.518.304
Profitability	Profit/Capital	17.72%	12.17%	9.47%
	Profit/Risk Weighted Assets	1.95%	1.03%	1.14%
	Net Interest Margin	3.04%	3.08%	2.63%
	Net Interest Income/Risk Weighted Assets	3.39%	4.00%	3.17%
Risk-Capital Adequacy	Risk Weighted Assets/Total Assets	65.21%	59.16%	72.24%
	Core Equity Ratio	9.67%	8.43%	10.86%
	Capital Adequacy Ratio	13.77%	9.31%	12.91%
Provisions Adequacy	Annual Provisions/Net Interest Income	16.24%	20.46%	20.94%
	Accounting Provisions/Regulatory Provisions	65.73%	96.74%	76.84%
	Non-Performing Loans net of Provisions/Regulatory Capital	14.62%	46.07%	24.91%
	Regulatory Provisions Shortfall/Regulatory Capital	4.51%	3.65%	10.67%

From 2007 fiscal year balance sheets analysis of the three representative Banks, the 80%, 65% and 10% of the capital comes mainly from deposits and loans for Bank 1, 2 and 3 respectively, which based on their nature and characteristics are elements that generate costs. It should be mentioned that 2007 was a crucial period for Greek Bank System since, starting from August 2007; the financial crisis began to exert upward pressure on Bank interest rates in the money markets of developed economies while the monetary and credit magnitudes kept on exhibiting large increases.

For capital requirements calculation under IRB approach, exposures were divided into three categories according to their supervisory handling. Of particular importance in calculation is the parameter of exposures coverage by conducting relevant provisions, as defined by the regulatory framework (Basel I and Basel II). For each Bank, three scenarios were implemented, based on the extent of the provision to default loans. The diversification of regulatory factors implies on 1) the non default and default loans, 2) retail and corporate banking, 3) the mortgage lending, depending on the collateral (LTV: Loan to value). Furthermore, general provisions should be created against the possibility of future losses for each exposure (collective or individual basis), as defined by the regulatory framework (Basel I and Basel II).

The model attempts to estimate the risk of lending in order to identify the corresponding capital requirements for Banks credit risk and their capital adequacy. Since different types of assets have different risk profiles, weighting assets according to their level of risk primarily adjusts for assets that are less risky by allowing Banks to discount lower-risk assets. Risk weighted assets are calculated for all portfolios of the three Banks, based on the type of the exposures and scenarios are applied were risk elements (such as exposure, profitability of default, failure to fulfill counterparty's obligation etc.) are applied. Then capital requirements were recalculated based on new conditions (worsens or not).

3. IRB Approach

3.1. Calculation Procedure for Financial and Indices

Under the IRB approach and based on predefined criteria, which draw on the general characteristics of exposures, exposures were divided into three categories with similar characteristics based on their inherent risk. Risk is determined based on counterparty's probability of default (PD) and Loss Given Default (LGD) for each category of performing loans (non-defaults). Default probabilities are calculated using Banks IRBs, while correlations are determined by the Central Bank of Greece. An important factor that should be also calculated is the exposure at the time of default (EAD).

This approach provides greater risk sensitivity than Basel II (ST approach) and Basel I tailored to the institution's risk profile, through more risk buckets and higher risk weights compared to ST approach or standard risk weights that Basel I applied. In addition, in order to raise the quality and the level of the capital base, there is need to ensure that all material risks are captured in the capital

framework.

For capital requirements calculation in the IRB approach, for all representative Banks, three scenarios were applied with different values of risk parameters. Assumptions that were assumed and scenarios that were implemented were based on Banks economic figures until 2007. The first scenario is characterized as the most rigorous for holding additional capital, since it is referred to high values of risk parameters, and so relevant provisions approaches are required by the supervisory authority (Central Bank of Greece). The third scenario is the most favorable scenario, while the second scenario refers to an intermediate level between risk parameters and their coverage of regulatory and accounting provisions.

For the three representative Banks the results of quantitative analysis are reflecting in **Tables 2-8**. **Table 2**, **Table 4** and **Table 6** gives portfolios structure (non defaulted and defaulted) with relevant risk exposure, as percentage (multiplying default risk and loss given default) per Bank. The results of the three above scenarios that were executed per Bank are included in **Table 3**, **Table 5** and **Table 7**. Defaulted loans were weighted with 100%, according to the IRB approach. Finally, **Table 8** is referred to Bank 1, 2 and 3: The amount of risk weighted assets with Basel II (RWA-Credit-Basel II (1)), the amount of risk weighted assets for operational risk (RWA-Operational Basel II (2)), provisions based on Basel II (Provisions-Basel II (3)), provisions based on accounting standards (Provisions-IAS (4)) the difference between the two methods of forecasting (Provisions-Shortage of capital (5)), the amount of risk weighted assets which is equal to the sum of the initial amount of weighted assets as of operational risk and the regulatory deficit that is generated from accounting provisions, the total weighted assets under Basel II, total risk weighted assets based on the framework set by Basel I and the final relief of charge of total risk weighted assets for both Accords (Delta-RWA).

Table 2. Bank 1 risk weighted analysis (in thousands Euro).

Portfolio Type	Balance	RWBasel I	RWIRB		
			Scenario		
			1	2	3
Small Enterprises (non-defaulted)	20,317,708	100%	94.6%	58.8%	41.0%
Small Enterprises (defaulted)	882,523	100%	0.0%	0.0%	0.0%
Large Corporate (non-defaulted)	63,693,041	100%	101.6%	74.9%	34.8%
Large Corporate (defaulted)	2,719,584	100%	0.0%	0.0%	0.0%
Mortgage LTV < 75% (non-defaulted)	30,035,466	50%	24.4%	14.1%	3.8%
Mortgage LTV < 75% (defaulted)	1,093,453	50%	0.0%	0.0%	0.0%
Mortgage LTV > 75% (non-defaulted)	3,397,417	50%	40.7%	21.2%	7.0%
Mortgage LTV > 75% (defaulted)	152,839	50%	0.0%	0.0%	0.0%
Retail (non-defaulted)	19,329,601	100%	55.1%	55.1%	55.1%
Retail (defaulted)	901,719	100%	0.0%	0.0%	0.0%

Table 3. Bank 1 risk weighted analysis per scenario (in thousands Euro).

Portfolio Type	Scenario 1		Scenario 2		Scenario 3	
	Basel I	Basel II	Basel I	Basel II	Basel I	Basel II
Small Enterprises (non-defaulted)	20,248,083	19,220,552	20,078,779	11,946,812	20,077,179	8,330,260
Small Enterprises (defaulted)	826,518	-	857,333	-	864,815	-
Large Corporate (non-defaulted)	63,757,712	64,712,130	63,236,728	47,706,088	62,859,782	22,165,178
Large Corporate (defaulted)	2,547,000	-	2,641,959	-	2,665,015	-
Mortgage LTV < 75% (non-defaulted)	14,529,787	7,328,653	14,709,963	4,235,000	14,739,302	1,141,347
Mortgage LTV < 75% (defaulted)	512,031	-	531,121	-	535,756	-
Mortgage LTV > 75% (non-defaulted)	1,678,657	1,382,748	1,670,780	720,252	1,669,395	237,819
Mortgage LTV > 75% (defaulted)	71,569	-	74,238	-	74,886	-
Retail (non-defaulted)	18,778,836	10,650,610	19,081,877	10,650,610	19,155,456	10,650,610
Retail (defaulted)	844,496	-	875,981	-	883,625	-
Total	123,794,694	103,294,694	123,758,763	75,258,763	123,525,215	42,525,215

Table 4. Bank 2 risk weighted analysis (in thousands Euro).

Portfolio Type	Balance	RWBasel I	RWIRB
Small Enterprises (non-defaulted)	6,784,562.74	100%	88.95%
Small Enterprises (defaulted)	541,833.26	100%	0.00%
Large Corporate (non-defaulted)	12,787,654.26	100%	109.37%
Large Corporate (defaulted)	2,004,114.74	100%	0.00%
Mortgage LTV < 75% (non-defaulted)	15,065,652.00	50%	15.38%
Mortgage LTV < 75% (defaulted)	826,638.00	50%	0.00%
Mortgage LTV > 75% (non-defaulted)	1,380,297.00	50%	33.28%
Mortgage LTV > 75% (defaulted)	86,289.00	50%	0.00%
Retail (non-defaulted)	5,891,266.00	100%	68.88%
Retail (defaulted)	901,719.00	100%	0.00%

Table 5. Bank 2 risk weighted analysis per scenario 1 (in thousands Euro).

Portfolio Type	Scenario 1	
	Basel I	Basel II
Small Enterprises (non-defaulted)	6,694,840.59	6,034,868.56
Small Enterprises (defaulted)	476,987.56	-
Large Corporate (non-defaulted)	12,931,053.22	13,985,857.46
Large Corporate (defaulted)	1,764,265.63	-
Mortgage LTV < 75% (non-defaulted)	6,908,616.28	2,317,097.28
Mortgage LTV < 75% (defaulted)	363,853.67	-
Mortgage LTV > 75% (non-defaulted)	662,528.46	459,362.84
Mortgage LTV > 75% (defaulted)	37,981.04	-
Retail (non-defaulted)	5,671,852.30	4,057,904.02
Retail (defaulted)	543,242.98	-

Table 6. Bank 3 risk weighted analysis (in thousands Euro).

Portfolio Type	Balance	RWBasel I	RWIRB		
			Scenario		
			1	2	3
Small Enterprises (non-defaulted)	3,029,998.20	100%	92.72%	74.68%	72.57%
Small Enterprises (defaulted)	133,887.90	100%	0.00%	0.00%	0.00%
Large Corporate (non-defaulted)	8,787,838.80	100%	102.32%	95.27%	83.95%
Large Corporate (defaulted)	562,380.10	100%	0.00%	0.00%	0.00%
Mortgage LTV < 75% (non-defaulted)	2,707,838.00	50%	14.79%	7.40%	3.70%
Mortgage LTV < 75% (defaulted)	96,409.00	50%	0.00%	0.00%	0.00%
Mortgage LTV > 75% (non-defaulted)	1,227,767.00	50%	33.28%	25.88%	18.49%
Mortgage LTV > 75% (defaulted)	86,822.00	50%	0.00%	0.00%	0.00%
Retail (non-defaulted)	2,007,165.00	100%	75.77%	68.88%	59.04%
Retail (defaulted)	301,757.00	100%	0.00%	0.00%	0.00%

Table 7. Bank 3 risk weighted analysis per scenario (in thousands Euro).

Portfolio Type	Scenario 1		Scenario 2		Scenario 3	
	Basel I	Basel II	Basel I	Basel II	Basel I	Basel II
Small Enterprises (non-defaulted)	3,001,826	2,809,414	2,968,788	2,262,802	2,959,142	2,198,869
Small Enterprises (defaulted)	116,788	-	123,205	-	122,473	-
Large Corporate (non-defaulted)	8,813,877	8,991,716	8,754,675	8,372,174	8,667,594	7,377,390
Large Corporate (defaulted)	490,555	-	517,511	-	514,435	-
Mortgage LTV < 75% (non-defaulted)	1,232,151	400,489	1,261,884	200,380	1,247,035	100,190
Mortgage LTV < 75% (defaulted)	42,048	-	44,358	-	44,094	-
Mortgage LTV > 75% (non-defaulted)	587,665	408,600	590,256	317,746	580,901	227,014
Mortgage LTV > 75% (defaulted)	37,866	-	39,947	-	39,710	-
Retail (non-defaulted)	1,945,052	1,520,828	1,957,329	1,382,535	1,937,075	1,185,030
Retail (defaulted)	263,218	-	277,681	-	276,031	-

Table 8. Impact of Basel I and Basel II capital requirements (in thousands Euro).

	Bank 1			Bank 2		Bank 3	
	Scenario 1	Scenario 2	Scenario 3	Scenario	Scenario 1	Scenario 2	Scenario 3
RWA – Credit – Basel II (1)	103,276,900	75,274,311	42,525,926	26,855,533	14,130,925	12,535,364	11,088,148
RWA – Operational Basel II (2)	11,738,371	11,738,371	11,738,371	4,049,826	1,470,158	1,470,158	1,470,158
Provisions – Basel II (3)	4,039,181	3,347,421	2,655,413	2,213,415	787,316	697,425	605,841
Provisions – IAS (4)	2,655,279	2,655,279	2,655,279	2,141,714	605,038	605,038	605,038
Provisions – Shortage of capital (5) = (3)-(4)	1,383,902	692,142	134	71,700	182,278	92,387	803
RWA – Provisions Shortage of capital (6) = 12.5 × (5)	17,298,780	8,651,783	1684	896,262	2,278,486	1,154,848	10,039
RWA – Basel II (7) = (1) + (2) + (6)	132,314,052	95,664,466	54,265,982	31,801,622	17,879,570	15,160,371	12,568,346
RWA – Basel I (8)	123,753,654	123,753,654	123,753,654	36,304,617	16,566,124	16,566,124	16,566,124
Delta – RWA (7)-(8)	8,560,398	-28,089,187	69,487,671	-4,502,994	1,313,445	-1,405,753	-3,997,778

3.2. Bank 1

For the first representative Bank (Bank 1), the amount of assets is equal to €235 billion, while the capital is around €17 billion. The development of the three scenarios for the Bank 1 (**Table 2** and **Table 3**) gives the following results:

Table 3 shows the balance of risk weighted assets per portfolio after the execution of each of the three scenarios that were conducted for Bank 1.

In the first scenario, after using risk weighting based on Basel II aspects, the balance of risk weighted assets, with respect to the loan portfolio, will be equal to €103.3 billion. If risk weighted assets are implemented, unlike to Basel I, risk weighted assets will be equal to €123.8 billion. This reduction is due to consumer and mortgage loan portfolios, small businesses exposures, corporate exposures and defaults. Most important of all is the reduction that is observed in the loan portfolio due to performing consumer loans. It should be noted that Basel I defines factor of 100%, while Basel II defines factor equal to 55.10%, which is leading to a reduction of €8 billion. Mortgages loans for which the index is expressed as the ratio value of the loan to value of collateral (LTV) is less than 75%, and is mentioned as a critical factor. Reduction is also noticed in mortgage performing loans with collateral value less than 75%, from €14.5 billion, on Basel I to €7.3 billion for Basel II.

With IRB approach implementation (Basel II), a significant amount of less than 50% of weighted assets is calculated. The weighted elements, under IRB approach, do not correspond to a stable level (flat approach) eg. 50% that was applied in performing mortgages loans that are collateralised with houses (Basel I), or equivalent to 35% for LTV < 75% or 50% for LTV > 75%, that was set by ST approach (Basel II). It should be noted that Basel I for performing mortgages loans with collateral value less than 75%, but as well for performing mortgages loans with collateral value over 75%, the rate was the same and equal to 50%. Basel II diversifies the two categories, based on collateral and exposure value.

For the first category of performing mortgages, with collateral value lower to 75%, reduction of €7.2 billion due to existing collaterals. For the second category of performing mortgages with a collateral value over 75%, the reduction will be equal to €296 million. The lowest reduction is derived from the performed loans of SMEs portfolio. Weights are calculated to €20.2 billion portfolio as Basel I defines and €19.2 billion as of Basel II. The mentioned reduction is due to probability of default and expected loss of the bank, (1.52%). Basel II formulas, lead to lower risk weights (94.6%), compared with Basel I (100%). Corporate portfolio exposures (€63.7 billion) result in higher charges with Basel II (101.6%) than Basel I (100%) set. These factors determine higher risk weighted assets (with Basel II) by €954 million for defaulted loans, risk weighted assets are equal to zero, based on Basel II framework. For the above cases, unexpected loss is not recognized. For a loan that defaulted, the probability of default is equal to 100%, so unexpected loss does not exist and the relevant probability will be equal to one.

Default is failure to meet the legal obligations (or conditions) of a loan. Basel

capital framework prescribes a zero risk weight for Bank exposures on which adequate provisions are allocated. Any deviation from this amount of provisions leads to a capital requirement equal to the difference of the registered by the theoretical prediction that is set out in Basel. Risk weighted assets are equal to €103 billion (initial amount) plus €11.7 billion (risk weighted assets due to operational risk) plus the increase in risk weighted assets due to the two reporting frameworks deficit (banking supervisory perspective and IAS). Under Basel II, capital is set to maintain a regulatory confidence level (€132.3 billion), ensuring that capital allocation is more risk sensitive than Basel I (€123.7 billion). While a relief as of credit risk is occurred, equal to €20.5 mil, it is offset if operational risk (€11.7 billion) and lack of provisions (€17.3 billion) and risk weighted assets should be charged with €8.5 billion (capital charges €0.68 billion ($€8.5 \times 0.08$)). In the second scenario, exposures are equal to €142.5 billion. Given the risk factors, as defined by Basel I, the risk weighted assets will be in this scenario equal to €123.7 billion. Based on Basel II framework, the amount of risk weighted assets will be equal to €75.2 billion. From the quantitative analysis, improvement is noticed in all portfolios, with main impact in corporate performed loans. In case risk weight assets are reduced, as defined by Basel II (74.9%), compared to Basel I (100%), a reduction in additional assets is noticed which is equal to €15.5 billion. Equally important is the improvement observed in the portfolio of performed consumer loans. Due to the new framework (Basel II), portfolio's risk weight asset is reduced to 55.1% compared with Basel I which was 100%. Modification will reduce additional capital requirements on this portfolio, equal to €8.4 million. Basel II induces a similar improvement in performing SMEs portfolio which is matched to 58.8%. The change in risk-weight assets, is equal to €8.1 billion. Based on Basel II accord the amount of provisions that is calculated is up to €3.3 billion, while the allocated provisions, based on accounting standards are equal to €2.6 billion. Risk weighted assets will be increased by $12.5 \times (3.3 - 2.6) = €8.7$ billion, or to additional capital requirements, $3.3 - 2.6 = €692$ million risk weighted assets will be equal to €75 billion (initial amount) plus €11.7 billion (risk weighted assets due to operational risk) plus the increase in risk weighted assets (€8.7 billion) due to the two reporting frameworks deficit (banking regulatory perspective and IAS). Under Basel I, the amount of risk weighted assets is equal to €123.6 billion, lower than Basel II scenario applied, while risk sensitivity is not comparable for the risks undertaken. Relief as for credit risk is equal to €48.5 million if charges due to operational risk (€11.7 mil) and lack of provisions (€8.7 mil) are also calculated, then risk weighted assets will be equal to €28 billion and capital requirements will be €2.24 billion (28×0.08). The third scenario corresponds to low risk weighting parameters and regulatory provisions that are equal to the accounting ones. Risk factors, as defined by Basel I, determine weighted assets equal to €123.5 billion for total exposures equal to €142.5 billion. Based on Basel II, the amount of risk weighted assets will be equal to €42.5 billion. The higher relief is observed in corporate portfolio,

mortgage portfolio and small business and consumer loans portfolio. Lower risk weights that are adopted for certain asset categories permitted under Basel II, greater relief to portfolio exposures as for corporate portfolio, compared to Basel II (€40.6 billion). This reduction is due to lower risk factors (34.8% versus 100%) that Basel II introduces. Significant relief is observed in performing mortgage portfolio (€13.6 billion), based on Basel II framework, where weighted assets are decreased compared to Basel I (€14.7 billion). High relief is also observed in mortgage portfolio due to the weightings factor that is set (3.8%), in SMEs portfolios (41%) and in consumer loans (55.1%). For equal (marginal) provisions that are allocated, Basel II parameters and accounting standards lead in the recognition of the same provisions amount (€2.6 billion), which effect to no additional capital requirements ($12.5 \times (2.6 - 2.6) = €0$ billion). Consequently, risk weighted assets are equal to €42 billion (initial amount) plus €11.7 billion (risk weighted assets due to operational risk) and weighted assets will not be affected by provisions, since regulatory and accounting treatment is the same. Total risk weighted assets will be equal to €54.2 billion. Under Basel I, the amount of risk weighted assets is equal to €123.7 billion, which is higher for Basel II. Consequently, the relief displayed for credit risk is equal to €69.5 billion while the capital requirements are €5.56 billion ($€69.5 \times 0.08$). Lower risk weighted assets are due (mainly) to low values of risk parameters (PD, LGD).

3.3. Bank 2

For the second representative Bank (Bank 2), the amount of assets is equal to €76 billion, while the capital is €3.8 billion. Main findings for Bank 2 are summarized in **Table 4** and **Table 5**:

Due to the fact that provisions under IAS are close to the ones that Bank of Greece allocates, we considered not appropriate to develop different scenarios for Bank 2. Furthermore, for Banks with such characteristics (portfolio type, amount of provisions and collateral), results do not differ significant (% negligible).

The non defaulted mortgage portfolio with LTV < 75% and consumer credit portfolio are more strongly affected by the new framework with risk factors 15.4% and 68.9%, respectively, and weighted assets to be decreased compared to Basel I (€4.6 billion and €1.6 billion). For large corporate exposures, risk factors increase to 109.4%, leading to a withholding of a higher amount of additional funds, compared to Basel I, equal to €1 billion.

Table 5 shows the balance of risk weighted assets per portfolio after the execution of the scenario 1 that was conducted for Bank 2.

Bank's 2 loan portfolio is equal to €46 billion. Provisions based on IAS are close to those that are required by the Central Bank of Greece (BoG) and so it was considered not to be useful multiple scenarios to be examined, since the optimistic scenario (IAS) does not deviate significantly from the pessimistic (BoG). For a Bank with these characteristics (type portfolios, asset classes, provisions

and collaterals), changes in minimum capital requirements arising from the application of the three scenarios are minimum. Consumer portfolio and performing mortgages with LTV lower than 75% are more strongly affected by the new framework. Risk weights that are corresponded to both portfolios are 15.4% and 68.9%, respectively, which concludes to a relief equal to €4,6 billion and €1,6 billion. For corporate exposures, risk weights are increased to 109.4%, which leads to higher additional capital charges (€1 billion), compared to the ones of Basel I. Due to operational risk, a relief of €4 billion should be also considered. In case, whether lower provisions are allocated, risk weight assets are then increased. Based on accounting standards allocated provisions are equal to €2.1 billion, while Basel II requires €2.2 billion which will lead to higher risk weight assets equal to $12.5 \times (2.2 - 2.1) = €100$ million and consequently additional capital charges of €896 million risk weighted assets will be equal to €27 billion (initial amount) plus €4 billion (risk weighted assets due to operational risk). Whether provisions (€896 mil) are calculated, the total risk weighted assets will be equal to €31 billion.

According to Basel I, the amount of risk weighted assets is equal to €36.3 billion, which is higher than Basel II. Therefore, the relief is equal to €4.5 billion, while capital charges are equal to €0.36 billion (4.5×0.08). The incurred relief in risk weighted assets is due to low risk parameters (PD, LGD), which is higher from the relief due to operational risk.

3.4. Bank 3

For the third representative Bank (Bank 3), the amount of assets is equal to €24.8 billion, while the capital is €2,1 billion. Main findings for Bank 3 are summarized as follows (Table 6, Table 7):

Table 7 shows the balance of risk weighted assets per portfolio after the execution of each of the three scenarios that were conducted for Bank 3.

Bank 3 is the smallest of the three Banks and has a limited loan portfolio, which refers to higher capital requirements since the increase of defaults is more difficult to be absorbed than hedged.

In the first scenario, the greatest relief occurs in mortgages portfolio. Consumer loan and small business loans portfolio shows a relief of €0.4 billion and €0.2 billion, respectively. Charges are also observed (€0.18 billion) in corporate loans portfolio, where the rate is 102.2%. Regarding credit risk a relief is observed equal to $16.5 - 14.1 = €2.4$ billion. This reduction is weighted by €1.5 billion charge due to operational risk, and €2.3 billion due to lack of provisions. Therefore we have a total charge of €1.3 billion and a capital requirements charge of €104 million.

In the second scenario the greatest effect is in mortgage loans portfolio, where based on Basel II the rate is reduced to 7.4%, compared with 50% (Basel I), which leads in a reduction of €1.1 billion. In the consumer loans portfolio with total relief equal to €0.6 billion, weights are reduced from 100% to 68.8%. Equal-

ly important is the reduction in the SME portfolio (€0.7 billion), due to the reduction of the rate to 74.68% (Basel II) from 100% (Basel I). Regarding credit risk a relief is observed equal to $16.5 - 12.5 = €4$ billion which is hedged with €1.5 billion charge due to operational risk, and €1.15 billion due to lack of provisions. The risk weighted assets reduction due to credit risk is greater than the total relief due to other factors. Therefore we have a total relief of about €1.4 billion and capital requirements relief of €112 million. In the third scenario, there is further improvement in risk weighted assets, due to the very low price of risk parameters (PD, LGD). For capital requirements, a decline, particularly in mortgages loans, is observed for minimum expected loss (0.02%). For this type of assets, the risk parameters are so low that the risk weight is equal to 3.7% (significantly lower than 50%—Basel I). It is noted that low prices of risk parameters for this scenario, could hardly be described as realistic, in crisis period.

Highest relief is observed in mortgage loans where the weighting factor is equal to 3.7% for Basel II, compared to 50% in Basel I. This change leads to a reduction (€1.1 billion) of risk weighted assets. In corporate and consumer portfolio, the relief is lower. The total relief in these two portfolios for Basel II, will be €0.76 billion and €0.75 billion, respectively compared with Basel I scenarios. As it concerns credit risk, a relief is observed equal to $16.5 - 11.1 = €5.4$ billion. The reduction is hedged with a charge of €1.5 billion, due to operational risk, and €0.01 billion due to lack of provisions. Risk weighted assets relief due to credit risk is greater than the total relief due to other factors. Therefore, we have a total relief of €4 billion and capital requirements relief €320 million.

Table 8 determines risk weighted assets under Basel II for credit risk (RWA-Credit-Basel II (1)) and operational risk (Operational-Basel II (2)), provisions under the regulatory framework (Provisions-Basel II (3)), provisions under the internal accounting standards (Provisions-IAS (4)), shortage of capital under the two provisions method and relevant risk weighted assets, under Basel II framework (RWA-Basel II). Furthermore, the table gives information as for RWA and the capital reduction/relief under Basel II and Basel I framework (Delta-RWA (7)-(8)).

4. Conclusion

Challenges posed by the new framework are expected to drive Banks to achieve a better risk management and build an effective prudential framework. Indeed, in order to comply with the new regulation Banks improved their capital framework through upgrade of credit measurement and risk management practices. Furthermore, Banks offset the implementation cost of credit measurement and management systems upgrade in order to comply with the new regulation in order to derive the benefits.

Under the Basel II guidelines, Banks categorised their exposures into qualitatively differentiated layers of risk to use their own estimated risk parameters for calculating regulatory capital. Based on PDs' and LGDs' scenarios that were ap-

plied within the IRB approach, we have the following results: For the first scenario, which is the pessimistic one, but very realistic in times of crisis, the total capital requirements overall increase. A decrease of capital requirements, due to credit risk is observed but capital requirements due to operational risk and inadequate provisions are increased. In the third scenario, a reduction in capital requirements is observed, while PD and LGD seem to be unrealistic for the examined period. In particular, for the first scenario, which is considered realistic, the higher reduction of risk weighted assets is observed in mortgage and consumer portfolio (Bank 1). For Bank 2, except the two above mentioned loan categories, a reduction in corporate and retail portfolio also occurred. For Bank 3 a reduction is observed on mortgage and consumer portfolio, while on business retail loans portfolio a reduction of lower impact is observed. For Bank 1 and the first scenario, which was set to follow the rigorous version, risk weights are higher and so are general provisions (from registered ones), resulting to an increase of risk weighted assets equal to 6.8%. In the second scenario, which is an intermediate state between the first and third scenario a decrease of the risk weighted assets (22.6%), was noted. Finally, in the third scenario, where regulatory and accounting provisions that were calculated are almost equal, a reduction of 53.9% was observed. For Bank 2 there was only one scenario developed in which there is a decrease of risk weighted assets by 12.5%. For Bank 3 and the rigorous scenario a change of 7.8% was estimated. For the intermediate scenario, a reduction was observed equal to 8.3%, while in the optimistic scenario a relief was observed equal to 24%.

Basel Committee concluded that IRB approach might encourage Banks to develop forward-looking and risk-sensitive approaches in order to calculate capital charges per exposure. The appropriate calculation of charge capital requirements depends mainly on the exposure (book value), relevant impairments, collateral value, booked provisions and the methodology that the Bank adopts supervisory rules (foundation methodology) or internal assessments (advanced methodology). Indeed, based on our paper, riskier portfolios result in higher capital requirements for both approaches, with the greatest burden to be observed in IRBs based approach. As it concern retail and mortgage portfolios “benefit” as of credit risk, due to risk dispersion and collaterals (mortgages).

The impact of IRB in capital requirements depends on Bank’s portfolio structure (i.e. loan exposures to all segments, collateral, provision coverage etc.). According to the study, the main factors affecting the determination of capital requirements in the IRB approach are: 1) The amount and the type of each exposure. The higher is the exposure, the greater are the capital requirements. Based on the type of the exposure, corresponding calculations are made. Moreover, for certain type of exposures (SMEs, SBEs), maturity is a critical factor. 2) The counterparty risk, as reflected in the PD. 3) The recovery risk as reflected in collateral value and LGD. In conclusion, the greater the collateral value and the potential liquidation, the lower the capital requirements are. Banks focusing on re-

tail (such as Bank 2) are likely to benefit the most, due to risk weighting based on theoretical issues, which is contrary to study's results. This could be due to additional capital requirements of non performing loans and operational risk that are hedging this relief. Retail loans, excluding mortgages, include more loan loss provisions. Moreover, capital requirements due to operational risk were increased due to the spread that these loans have.

The IRB approach increases capital requirements based on the value of the risk parameters that are used, due to the fact that it is not a static but a dynamic methodology, as it takes into account not only the current situation due to the risk, but also the trend of the risks in the future. Such an approach is more appropriate for larger Banks, which can invest in risk management and are able to maximize profit to risk ratio. For smaller Banks, this methodology could lead to high risk, since they could not manage an unfavorable situation. Indeed, deterioration in the quality of credit portfolio can have a material adverse effect due to systemic reasons or due to poor management by the Bank, which may affect negatively on capital adequacy ratio and as well to capital requirements. Further research would be useful as other risks (i.e. market risk, operational risk etc) are not examined in our study. Indeed, Banks should apply strategies for management of all undertaken risks that should be monitored based on their regulatory framework.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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