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Abstract

Banks use internal models to optimize risk weights and better account for the specific risk of each asset class. As the choice of a set of risk weights directly amounts to affecting the regulatory capital ratio, economic theory suggests that banks should optimize their risk weights also with respect to the cost and benefit of holding equity capital. Banks with a higher cost of capital, and banks with better growth opportunities, should be more aggressive in reducing risk weights. We consider a large panel of international banks and find that, after controlling for a number of bank and country characteristics, banks do respond to the cost and benefit of holding capital when selecting their average risk weights. We also find that banks that are more aggressive in terms of such optimization have a subsequent lower return on equity and are more likely to have raised capital during the credit crisis.

1. **Introduction**[1]

Regulators have recently pushed for better capitalized international banks, especially after the credit crisis. As a result, banks like to show capital strength, particularly from the point of view of regulatory capital. Economic theory offers conflicting predictions about the relation between bank capital and value. In the standard Modigliani-Miller world there is no relation between the two, but agency costs may produce a negative relation, see e.g. Stulz (1990) and Diamond and Rajan (2001). However, Mehran and Thakor (2010) claims there is a positive relation between capital and value, and Allen et al. (2011) show that banks may use costly capital to commit to asset monitoring.

Risk-based capital regulation sets a minimum ratio between capital and risk-weighted assets. In the original version of the Basel regulation, so called Basel I, weights are imposed externally by the regulator. By definition, the resulting capital ratio cannot account for cross-bank heterogeneity and country characteristics. In the Basel II regulation, banks are given the possibility to choose their own weights by means of internal risk models, subject to a positive judgment on the part of national regulation authorities. Internal models should define weights purely on risk measurement considerations, i.e. the internal weights should be set to the level that best reflects the intrinsic riskiness of a given asset.

However, it is well known that, especially due to tax reasons, equity capital is the most expensive source of financing for banks. This opens the possibility that banks set their risk weights with the purpose of reducing the quantity of capital that is needed to support a given level and structure of total assets (so called risk weight optimization). A favourable set of weights would reduce the total amount of risk-weighted assets (RWA), making existing (equity and hybrid) capital more likely to comply with a regulation that is set in terms of the ratio between capital and RWA. We expect that the higher the cost of equity capital, the more serious the efforts of banks to optimize risk weights. As data on weights are not publicly available, in most of our empirical work

[1] The opinions expressed here are those of the authors only and do not necessarily represent the views of the affiliated Institutions.

we proxy risk weights with the ratio between RWA and total assets (so called density). We use panel data on a sample of large international banks to test whether the cost of equity capital is relevant to affect the density. While the null hypothesis is that the cost of equity has no effects on the density, our alternative hypothesis is that there is an inverse relation between the cost of equity and the density.

There are several reasons why this question is relevant. First, banks should not let the cost of equity capital drive the density to a level that does not properly account for risk. The density should be set at a level that is right for the true risk associated with the bank, in such a way as to achieve a level of equity capital that allows banks to be safe with respect to negative shocks. Evidence showing that the cost of equity affects the density raises the possibility that banks artificially inflate their capital ratios. Second, if density depends on the cost of equity capital, then there is a possibility that the playing field is not level at all, both nationally and internationally. As the euro-crisis has shown, there are well known effects of country characteristics on the public cost of funding, that pass through at the bank level as the cost of equity capital depends on long term government rates. Any heterogeneity in the cost of public funding across countries then translates into heterogeneity in the cost of equity capital for banks belonging to different countries, and this in turn affects the density. Unfortunately the final impact would go the wrong way: banks located in countries with a higher cost of funding would optimize their RWA to a larger extent, artificially inflating their capital ratios and ending up as less resilient to external shocks. The implication is that two banks with similar total assets and asset structures and that are similar in all characteristics except in their domestic country would have the same capital ratio but different ratios between equity and assets, with the bank located in the riskier country showing a higher leverage.

There is a growing literature on RWA, largely based on descriptive analyses. Using available Pillar III information, Keefe, Bruyette and Woods (2011) argues that there are large differences in risk weights across European banks, with weights on residential mortgages ranging from 6% to 30% and corporate risk weights going from 27% to 85%. Cannata, Casellina and Guidi

(2012) focuses on credit risk and shows that a large part of interbank dispersion across Italian banks is explained by the business models and by the use of internal-rating based (IRB) approach versus the Standardised approach. Mediobanca (2012) studies 25 European banks and claims that the loan-book mix and different business models hardly explain the key differences in asset intensity, that are instead mainly due to the different mix between IRB and Standardised. Barclays (2012) documents the existence of bank-level large temporal variations across time for most banks in its sample. Le Leslé and Avramova (2012) look at a sample of 50 systemically important banks from Asia Pacific, Europe and North America, documenting wide international heterogeneities in densities, with a negative trend over the recent period that may have been due to factors like the progressive application of internal models, changes in business mix, the business cycle. They show that RWA densities of European banks tend to be lower than those of Asian and North American banks and that retail banks tend to have higher densities than universal banks and investment banks. They also notice that the characteristics of banks' portfolios are important determinants of RWAs. Das and Sy (2012) look at the relation between RWA and market measure of bank's riskiness and find a positive relation in 2004-2006 but not during the credit crisis of 2007-2008.

Our paper differs from this literature. First, we do not simply describe differences across banks but use economic theory to formulate hypotheses that are tested on the basis of econometric models. We try to better understand the meaning of risk weight optimization and highlight a key element, the cost of equity capital, that could drive it. Second, our sample, represented by an unbalanced panel data of 548 banks from 45 countries over the period 2005-2011, is much larger than the ones considered in other papers, and can reveal differences across banks and across time, using the signals arising from several world countries that differ significantly in terms of economic and institutional environments. Third, our econometric methodology looks at a wide variety of estimation models, including a GMM estimation in a dynamic panel framework to account for endogeneity. Fourth, we consider a wide range of bank and country characteristics that have been highlighted by researchers as potential drivers of heterogeneity in risk weights. Fifth, we also collect information for a large subset of 86 banks reporting the share of exposure at default (EAD) subject to internal rating models in their Pillar III annual reports (for the year 2008-2011) and produce Tobit estimation where the dependent variable is the percentage of credit EAD examined by banks by means of the Internal Ratings-Based Approach (IRBA).

Our empirical analysis shows that the cost of equity capital is indeed a significant factor in explaining RWA optimization on the part of banks: the larger the cost of capital the lower the RWA density. We also find that the better are growth opportunities the more intense is risk weight optimization, as banks try to build up excess capital that may be used to finance future growth. Other factors work as expected: more traditional business models are characterized by higher risk weights, larger banks optimize more strongly, expected default frequency of the corporate sector is associated with larger risk weights, banks located in countries with better creditor rights also show larger risk weights. Most of the results are robust to using as a dependent variable the ratio between risk-weighted assets and assets or the share of credit exposure described by internal models. In an attempt to understand the general implications of this optimization activity, we find that banks that are characterized by more intense optimization have lower return on equity and have raised more capital during the credit crisis.

The plan of the paper is the following. Section 2 describes RWA optimization and discusses the main hypotheses to be tested in the empirical work; section 3 describes the data, section 4 presents the results of the empirical analysis, based on both a static panel methodology and a dynamic GMM system. Section 5 presents robustness and further insights about the consequence of RWA optimization, while section 6 concludes.

2. **RWA density optimization**

Banks face a capital dilemma. From the stability perspective, they need to have as high a capital as possible to be able to absorb losses (and thus increase the distance to default). However, from the performance perspective, they also need to realize an acceptable rate of return on capital, that can be more easily achieved through leverage and the reduction of the ratio between equity capital and total assets. In order to prevent managers to pursue excessive leverage, and the associated level of risk, regulators set a minimum ratio between capital and risk-weighted assets[2]. Under the Basel II approach, regulators leave some flexibility in the determination of risk-weighted assets through the so-called internal risk-based models. Under the internal ratings-based approach banks can classify their assets in a relatively large number of asset classes. The probability of default (PD) is estimated by the bank, whereas the other relevant parameters like the loss given default (LGD), exposure-at-default (EAD) and maturity (M) can be provided by the regulator itself (Foundation IRB or FIRB) or estimated by banks and validated by supervisors (Advanced IRB or AIRB). Unlike in the original Standardised Approach[3], in IRB risk weights are continuous function of the risk parameters. It follows that banks, particularly those following AIRB, have considerable flexibility in measuring assets risk. The purpose of this flexibility lies in the knowledge that managers know the specific characteristics of banks better than the regulator, and as a result can use their information set to measure risks in a proper way.

Flexibility also amounts to partially allowing managers to choose how to meet their own capital requirements: by reducing weights applied to assets, they can increase the current ratio between capital and RWA. This opens the way to RWA optimization. The bright side of such optimization is the possibility to better tune the capital needs to the actual risks run by the banks. The dark side is the selection of a level of capital that may be low with respect to the actual risks. A bank that is short of regulatory capital may reduce risk weights and become compliant even without raising new capital. As a result of risk weight optimization, leverage would be higher than the level that would have been associated with a capital increase. RWA optimization is therefore potentially

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[2] There is a broad literature, largely associated with the 2008 credit crisis, suggesting that regulation should look at the ratio between capital and assets as well as the actual amount of capital in order to force banks to respect the minimum levels through capital accumulation rather than asset disposure. See Admati and Hellwig (2013) for a general discussion.

[3] Under the Standardised Approach risk weights depend on the external ratings; the number of risk buckets is small; for past-due loans some degree of discretion can be exercised by national authorities in reducing the risk weight according to the degree of provisioning of each loan.

linked with capital optimization and regulatory capital reduction. Our hypothesis is that a higher cost of equity capital can induce banks to increase leverage and therefore to decrease risk weights. A host of other bank-specific and environmental factors, partly highlighted by the existing literature, may also affect this optimization process. In what follows, we describe the variables that may affect the RWA density and the variables that may drive the optimization process. The first two hypotheses are the core of our paper and testing. The remaining five hypotheses include variables, some of which have already been discussed in the literature, that have clear implications on the RWA density. Finally, we discuss creditor rights and claim that it may have a theoretical unclear impact on the density.

Hypothesis 1: The higher the cost of equity capital the lower the RWA density.

From a cross sectional point of view, banks with a larger cost of equity capital will optimize more. The larger cost of equity capital may be due to a higher systematic risk and/or to country factors, like a higher long-term interest rate.

Hypothesis 2: The higher are growth opportunities the lower the RWA density.

The relation between expected returns on equity and RWA is affected by growth opportunities that may require capital as well as external funds. If bank managers foresee good profit opportunities they will try to reduce RWA density in order to have a capital buffer that may support more lending.

Hypothesis 3: The larger the size of the bank the lower the RWA density.

The implementation of Basel II, and the connected development of internal rating based models to a wide range of risks and counterparts, has provided flexibility in the assessment of RWA. This flexibility may however be achieved only by investing a substantial amount of resources in the development of a large and skilled risk management team. The bank's decision to move from a standardized to an IRB approach implies a relevant investment which is more easily undertaken by larger institutions. (see Hakens and Schnabel (2011) for a theoretical approach on this issue).

Hypothesis 4: Traditional and retail-oriented business models are characterized by higher RWA density.

Since loans carry large risk weights, banks' portfolio composition may strongly affect the density. There are assets, such as national government bonds, that do not consume economic capital (see Cannata et al 2012) while retail activity is more likely to have higher risk weights with huge differences across countries.

Hypothesis 5: IFRS-based accounting is characterized by lower RWA density.

Accounting standard differences introduce a bias in the way total assets are computed as the netting of derivatives positions is authorized under US GAAP and not allowed under IFRS. Thus the off-balance sheet positions would appear "larger" on an IFRS basis. IFRS implementation is empirically associated to higher total adjusted assets and consequently to lower RWA density, see Le Leslé and Avramova (2012).

Hypothesis 6: The stricter the supervisory control, the larger the RWA density.

Strict supervisory controls may determine prudent behaviour from the management and a higher RWA density. Basel II recognizes an important role to supervision in risk assessment as approval and validation of IRB models is a key element of the new capital regime. The positive relation can also be due to the evidence that regulatory restrictions increase bank taking incentives and thus the investment in risky assets (Gonzales,2005).

Hypothesis 7: the higher the borrowers' risk, the larger RWA density.

An increase in the average default probability of borrowers implies a revision of bank's PD and thus higher RWA. This represents the potential procyclicality caveat of the Basel Capital Accord. So long as rating systems are responsive to changes in borrower default risk, risk weighted assets will increase and consequently capital requirements will tend to increase as an economy falls into recession and fall as an economy enters an expansion. (Catarineu-Rabell et al. 2005).

Hypothesis 8: the index of Creditor Protection has an uncertain impact of the RWA density.

Stronger creditor rights are associated with increased lending to a wider and potentially riskier set of borrowers, see Djankov et al. (2007), higher bank risk taking, as shown empirically by Houston et al. (2010), and by lower corporate risk taking, as shown by Acharya et al. (2009). The latter is due to risk aversion on the part of the management that tries to decrease the probability of distress and may also try to a decrease in the demand for bank credit. The final impact of creditor rights on the RWA density depends therefore on which channel is stronger.

3. **Data**

The empirical analysis uses an unbalanced panel data set of 548 banks from 45 countries over the period 2005-2011 (see the Appendix A for the list of countries and the number of banks per country). The availability of bank specific and country specific variables leads to a sample of around 1,000 bank-year observations. A cross-country study is appropriate because variation in RWA density across countries is likely to be greater than cross-bank variation within countries.

Our dependent variable is the ratio between risk weighted asset and total asset (RWTA)[4]. The banks included in our sample have total assets larger than USD 1 billion as of 2010 and must have data on risk weighted assets for at least five years[5].

[Insert figure1 around here]

[4] EBA (2013) and Cannata et al. (2012) use the ratio between RWA and EAD as a proxy for the average risk weights. We have data on EAD only for a small sub-sample of mainly European banks.

[5]We remove observations regarding two banks (Comdirect and SCBT) where the RWTA were anomalous.

Figure 1 displays the variability of the RWA density across countries, years, and banks. Panel A shows the existence of substantial variations across countries and within each country. The country mean can be as low as 0.2 and as high as 0.8. Dispersion within each country is also widely heterogeneous. Panel B shows the RWTA for each bank across time and suggests that there has been a very relevant temporal variability. Panel C shows that, across time, the average RWTA is stable at approximately 60%. Figure 1 confirms that it is useful to study the RWA density through a large sample of international banks observed through time. The relevant sources of cross-bank, cross-country and cross-time variability should provide strong signals to uncover the factors determining the RWA density.

Table 1 shows the characteristics of the RWTA for the full sample and for the two subgroups of countries that adopt or do not adopt Basel II. Summary statistics show that countries that do not use Basel II have a RWTA of 70.29%, against 60.53% of banks subscribing to Basel II. The t test of the mean difference for the two subsamples rejects the null of equality of means at any probability level. Basel II seems to be a relevant factor in driving the decisions of banks to select the RWTA, even though it may only be a proxy for other variables.

[Insert table 1 around here]

In our regressions we consider several variables, both at bank and at the country level, to minimize the risk of attributing density differences to observable elements of cross-bank heterogeneity like those discussed in the literature, see e.g. Cannata et al. (2012, Le Leslé and Avramova (2012). The main data source for bank's characteristics are Bureau van Dijk's Bankscope and bank's annual reports. All financial variables are converted into US dollar.

[Insert table 2 around here]

Summary statistics of bank-level variables are reported in Table 2, panel A. All the variables have been winsorized at the 1% and 99% percentiles of their distribution to reduce the influence of outliers and potential data errors. Approximately half of the banks in the sample adopt an IFRS accounting standard, and more than 60% follow the Basel II regulation. The average annual increase in the loan to asset ratio is only 0.4%, coherently with the slow-down in economic activity associated with the credit crisis. The average price-to-book ratio is 1.17 with a median close to 1. The average ratio between net interest income and total assets (net interest margin, taken as a proxy of the business model) is 3%. The median beta (measured from a market model regression for each bank with respect to the correspondent local equity index described in Appendix A) is close to 1 with a substantial standard deviation; such heterogeneity is welcome as our main hypothesis is about the relation between the cost of capital and the RWA density. The ratio between equity and total assets is 8.34% but goes down to 7.19% when tangible equity is considered. The average return on equity is 7.14% with a median of 10.17% and a large standard deviation due to observations with low or negative return on equity. Impaired loans are on average 4.37% of gross loans. The average tier one ratio is 12.22%. The natural logarithm of the z-score, which indicates the number of standard deviations that a bank's rate of return on asset has to fall before it becomes insolvent see Laeven and Levine (2009), is equal to 3 on average. Average total assets for the banks adopting the Basle 2 regime is equal to USD 176 bn.

Table 2, panel B, provides summary statistics for country level variables, that we gather from several databases: the legal origin of the country where the bank's headquarter is located and the degree of creditor rights come from Djankova et al. (2007); the World Bank ''Doing Business'' provides information regarding the recovery rate in case of insolvency and the strength of legal rights; the World Bank Survey on Bank Regulation and Surpervision 2008 and 2012 are used to construct the variable Official, measuring the power of the commercial bank supervisory agency; the index of financial freedom comes from the Heritage Foundation; finally, the Report to G20 leaders on Basel III implementation by the Bank of International Settlements (June 2012) and the answer 3.1 (part 3 on Capital) of the World Bank Bank Regulation and Surpervisory survey (December 2012) are used for constructing the dummy Basel II that provides information on whether the country applies the Basel II capital regime.

4. **Empirical analysis**

We consider both a static approach and a dynamic approach. The static approach models the level of the density at each point in time on the basis of variables that are determined in previous periods. The dynamic approach includes the lagged level of the density in the specification and looks at the contemporaneous impact of the variables on the current density. Both approaches may be justified by both the characteristics of the sample of data and the economic theory behind the specification.

4.1 ***A static approach***

In our static approach we explain the RWA density of bank *i* belonging to country *j* at time *t* on the basis of variables determined at time *t-1*

$$d_{i,j,t} = \beta_1 CC_{i,t-1} + \beta_2 RC_{i,t-1} + \beta_3 BM_{i,t-1} + \beta_4 CE_{j,t-1} + \varepsilon_{i,j,t} \qquad (1)$$

CC is the cost of capital, that we proxy with the beta of the bank (measured in the previous year to avoid endogeneity problems) and the long term interest on government bonds. Notice that our measure of the cost of capital is time-varying. ***RC*** is the benefit of holding capital proxied by the price to book ratio. The previous two variables represent the main interest of our estimation.

BM represents the business model of the bank, that we proxy with the net interest margin. This measure accounts for the difference between traditional relationship banking and transaction oriented activities, see also Demiurguc-Kunt and Huizinga (2011). We expect this coefficient to be positive because regulation implies higher risk weights for commercial banking activities that cannot be completely unwind by the application of internal models.[6]

CE represents proxies for environmental factors. There are two effects here, one relevant at the static level when comparing banks located in different countries, and one relevant at the

[6] We also use the winsorized ratio between total loans and customer deposits, obtaining very similar result in terms of relevance of both the business model and the other explicative variables.

dynamic level within each country. At the static level, different countries are heterogeneous regarding (fixed or slowly changing) institutions, laws and accounting standards that affect contracts and creditors rights. At the dynamic level, risk may increase in a country because of a specific policy shock so that banks using internal models may be forced to update their PDs to account for an increased level of defaults. Moreover a country could have a more oscillating cycle (e.g. the USA) while another country (e.g. a European country) may have less volatility (compensated by lower average growth) due to differences in labour market flexibility, role of the State , degrees of protection of creditors and investors.

In terms of proxies, we alternatively use fixed country effects and a number of proxy variables (see description in Appendix B). The variables that we identify are the following. The first is the expected default frequency of the corporate sector (EDF), that may proxy for general riskiness of the lending environment. The second is the index of official power (*OFF*) to measure the impact of regulation. The third is a dummy that is equal to one when the country has signed up to Basel II (*BAS*). The accounting standard is represented by a dummy that describes the use of local GAAP or IFRS. Finally, to measure the institutional environment we use the index of creditor rights from La Porta et al. (1998) that assembles information on reorganization and liquidation procedures, see Appendix B for its description. We alternatively use four other indexes. The first is a dummy equal to one when the legal origin is represented by the common law, that usually is associated with a higher loan to asset ratio and a higher degree of legal rights protection (Cole and Turk Ariss 2011). La Porta et al. (1997, 1998), find that legal origin explains much of the cross-country variation in legal protection of investors. Beck, Demirguc-Kunt and Levine (2003) and Djankov et al (2007) establish that credit from financial intermediaries to the private sector as a share of GDP is higher in countries of British legal origin. The second is the strength of legal rights, measuring the effectiveness of collateral and bankruptcy laws, obtained from the World Bank Doing Business Indicator. The third is the index of Financial Freedom, also used by Demirguc-Kunt and Huizinga (2009), that measures the openness of the financial system by looking mainly at the relevance of the public sector and its involvement in the allocation of credit.[7] The fourth is the recovery rate which is inversely related to the LGD. Recovery procedures, usually considered bank-specific, are strongly affected by national practices. These factors play a role in the risk management decisions as different recovery track records are associated with different risk weights and can modify bank officers' risk aversion.

Pairwise correlations between bank-level variables (Panel A of Table 3) and country variables (Panel B of Table 3) are generally small.

[Insert Table 3 around here]

The results for panel regressions with fixed effects (year and country) and lagged bank-level variables are shown in table 4.

[Insert Table 4 around here]

Column 1 presents the basic specification; bank's control variables are added in turn in the remaining columns. The results confirm most of our hypotheses. Beta is not significant, but the interaction between beta and the Basle dummy is negative and significant in all specifications. To judge the economic significance of this coefficient, a two standard deviation increase in the interaction BETA*BAS is associated with a reduction in the density of 5.4% that corresponds to a RWA saving of approximately USD 5 bn on average. The interpretation is that high-beta banks working in the Basle II framework have a lower RWTA, consistent with the hypothesis that stronger incentives to save capital lead to more optimization whenever this is allowed by regulation. Interestingly, the Basle II dummy variable by itself is not statistically significant. The price-to-book[8] has a negative coefficient: growth opportunities require banks to increase assets; in order to avoid raising capital, banks may decide to optimize risk weights more aggressively.

[7] The index has been used to proxy for risk-taking on the part of banks, but Gonzales (2005) has shown that its relation with risk-taking is empirically ambiguous.

[8] We also try the interaction between the variable representing the benefit of capital and the dummy representing the jurisdictions adopting Basle2. Given the lack of statistical significance and the lack of space we do not report the correspondent specification in table4 but results are available upon request to the authors..

The net income margin is positive, confirming that traditional banking activity is associated to higher risk weights. The accounting dummy is negative, as expected. We also control for other bank level variables: the log of total assets, ratio between equity and total assets, the ratio of non-performing loans to gross loans, the log of the Z-score. The log of total assets is always significantly negative, as big banks use their risk departments to develop internal rating models. The adoption of the IRB approach requires the construction and maintenance of large internal databases, the acquisition of expertise necessary to build rating systems for each class of counterparts comparable to those available from recognized external credit assessment institutions (ECAIs) and several accurate validation procedures by the national supervisory body. The ratio of the book value of equity to total assets[9] is used to evaluate the incentive stemming from the level of capitalization. Given the regulators focus on adequate capital ratios we assume that banks with high level of capital may have less motivation to pursue RWA optimization policies. Table 4 provides support to our interpretation. The ratio of non-performing loans to gross loans, in principle, should boost the stock of risk weighted assets as it worsens the risk profile of the loan portfolio. Finally, we control for the idiosyncratic risk by including the log of the z-score. Interestingly, the last two control variables exert no significant impact on the RWTA density.

An alternative way to account for country-specific effects is to introduce country level variables into equation (1).

[Insert Table 5 around here]

The basic results regarding bank characteristics are unaffected by the introduction of country specific variables, except for the significance of the accounting standard (A) and of the beta coefficient (BETA). As to the cost of capital, the overall effect (the sum of the coefficients of BETA and BETA*BAS) remains negative for banks belonging to jurisdictions adopting the Basle 2 framework. The positive relation between BETA and the density for banks not belonging to Basle II

[9] Alternatively we tried the ratio of tangible equity to total assets, with no difference in results. In the tables we kept the EQTA ratio simply to avoid the loss of observations due to a larger number of missing value associated to goodwill and other intangibles.

may be due to the impact of systematic risk. The lack of such a relation in the previous specification may have been due to the presence of fixed country effects absorbing the impact of BETA. Among the country level variables the average Expected Default Frequency (EDF) of the national corporate sector and the degree of official monitoring are significant and of the expected sign, as higher environmental risk forces the banks to maintain higher risk weights and more severe regulators prevent banks from over-optimizing. Creditor rights is positive and significant only when the variable Legal rights is also included in the regression (it appears with a negative sign). We have already pointed out that their sign could be either negative or positive depending on the relative strength of demand and supply channels. As to other proxies of the institutional setting, the recovery rate is negative and significant while the index of Common Law and the index of Financial Freedom are not significantly different from zero.

4.2 ***The dynamic model: the system GMM approach***

To allow for potential autocorrelation in RWA's we estimate a dynamic version of (1):

$$d_{i,j,t} = \alpha d_{i,j,t-1} + \beta_1 CC_{i,t} + \beta_2 RC_{i,t} + \beta_3 BM_{i,t} + \beta_4 CE_{j,t} + \gamma_j + \mu_t + \varepsilon_{i,j,t} \quad (2)$$

where $\gamma_{j,}$ and $\mu_{t,}$ denote sets of country dummies and time effects and $\varepsilon_{i,j,t}$ is the error term with $E(\varepsilon_{i,j,t}) = 0$ for all i, j and t.[10]

Difference GMM estimator of equation (2) as proposed by Arellano and Bond (1991) is based upon the following orthogonality conditions:

$$E(d_{i,j,t-s} \Delta\varepsilon_{i,j,t}) = 0 \text{ for } t = 3,...,T \text{ and } 2 \le s \le T-1 \quad (3)$$

[10] We can rewrite (2) as $\Delta d_{i,j,t} = (\alpha - 1) d_{i,j,t-1} + \beta_1 CC_{i,t} + \beta_2 RC_{i,t} + \beta_3 BM_{i,t} + \beta_4 CE_{j,t} + u_{i,j,t}$ so the model can be estimated in levels or first differences.

The second and further lags of $d_{i,j,t-s}$ are used as instruments for the residual of equation (2) in differences. However this estimator suffers from potentially small sample bias when the number of time periods is small and the dependent variable is persistent, see Alonso –Borrego and Arellano (1999). Arellano and Bover (1995) and Blundell and Bond (1998) suggest the use of System Generalized Method of Moment (System GMM) that bypasses the finite sample bias if one assumes mild stationarity on the initial conditions of the underlying data generation process. This method seems appropriate also for a number of reasons: (i) it controls for the possible problem of reverse causality of many of the explicative variables used in the specification, (ii) it does not require a distributional assumption on the error term, (iii) it is suitable for a relatively large number of cross-section observations compared to time series observations. In addition to the moment conditions specified in equation (3) system GMM uses the following moment conditions:

$$E(\Delta d_{i,j,t-1}(\delta_{jt} + \varepsilon_{i,j,t}) = 0 \text{ for } t = 3,...,T \qquad (4)$$

We use lagged first differences of the dependent variable to construct the orthogonality conditions for the error term of equation (3) in level. Additional orthogonality conditions for system GMM arise from suitable lags of the lagged explanatory variables in levels which can be treated either as exogenous, predetermined or strictly exogenous. The number of instruments tends to increase exponentially altering the reliability of results. Thus we follow Roodman (2009) and implement his routine to collapse instrument matrix and use only one lag of the dependent variable[11]. The standards errors of panel data estimators also need to be adjusted because each additional time period of data is not independent of previous periods. We thus compute robust standard errors and treat all bank-level variables as predeterminated. Dummy and country-level variable are treated as strictly exogeneous. Table 6 reports one –step system GMM estimates of equation (2)[12]:

[Insert Table 6 around here]

[11] All GMM estimations are carried out using the xtabond2 package in Stata (see Roodman 2009)

[12] Technically, the two-step estimator is asymptotically more efficient. However Monte Carlo studies have shown that the efficiency gain is typically small, and that the two-step GMM estimator has the disadvantage of converging to its asymptotic distribution relatively slowly. In finite samples, the asymptotic standard errors associated with the two-step GMM estimators can be seriously biased downwards, and thus form an unreliable guide for inference (Bond, Hoeffler, and Temple 2001).

We report three main tests to determine the appropriateness of our dynamic GMM estimations. The Arellano-Bond test for autocorrelation of the errors, with a null hypothesis represented by no autocorrelation in differenced residuals (more specifically, the second-order test in first differences for autocorrelation in levels). The Hansen test of overidentifying restrictions with the null hypothesis of exogeneity of the instruments. If the null hypothesis is not rejected, the instruments are valid. A further test is the Diff-in-Hansen test for the validity of the additional moment restrictions necessary for system GMM given in equation (4). In all cases the Arellano-Bond test for zero autocorrelation shows that at order 2 there is no evidence of serial correlation and the p-values of the Hansen tests do not reject the null hypothesis. In summary our test statistics hint at a proper specification.

Table 6 reports six regressions of the RWA density. Regressions 2- 6 differs from regression 1 in that they include a set of country variables. In all regressions, the bank level variables enter with the expected sign when significant. Differently from the results in table 4 but in line with those of table 5 we find that the variable associated with the cost of capital is significant (at least at 5% level) and positive. Again, the coefficient of beta is smaller than the negative coefficient of the interaction between Beta and Basle II, but the composite effect seems small. Contrary to results presented in table 5, the dummy variable Basle II (here treated as purely exogenous) is positive and statistically significant. Finally, the estimates confirm the relevance of the selected country-level variables. In particular, EDF, Official and Creditor rights show a positive impact on the RWA density. Moreover, the proxies for risk taking, whose signs are theoretically ambiguous, turn out to be significant and positive, suggesting that more advanced institutional frameworks lead to lower degrees of risk aversion of bank's managers. Changes in sign and significance for some of the regressors are not uncommon when moving from a static to a dynamic approach (see Soto 2010) and this could be due to the fact that panel OLS does not account for persistence of the data generation process.

5. Robustness and further insights

5.1 ***Robustness***

Table 7 presents the parameter estimates obtained substituting PB with two alternative measures of business opportunities, the return on average equity (ROAE) - column (1) and (2)- and the future growth of loans DLOTAF, in columns (3) and (4).

[Insert Table 7 around here]

Ordinary panel data analysis cannot cope with the endogeneity problem due to the use of the future value of the percentage change of gross loans, thus we implement a panel IV GMM regression, where the instruments are the first two lags[13] of the same variable. Column (1) and (3) show specifications without control variables which are instead accounted for in column (2) and (4). The statistical significance and sign of the relevant explicative variables holds as in table 4.

The results in table 4 and 7 are robust to the replacement of EQTA, with the ratio between Tangible Equity and total assets, with the T1ratio, and to additional control variables such as Fragility. To account for macro cyclical conditions we also include in the regressions the GDP growth, and the ratio between public debt and GDP. Furthermore we run a number of additional regressions where we iteratively include a wide range of country-level variables representing regulatory, governance and financial structure variables that have been examined by other researchers as a proxy of the risk taking attitude of bankers.[14] Most of these variables are highly correlated and cannot be included in a single model. Among the regulatory variables[15] we consider Capital (an index of regulatory oversight of bank capital), Monitor (an index that measures the degree to which regulations empower, facilitate, and encourage the private sector to monitor banks) and an index of Deposit Insurance.

We also take into account additional governance variables including Rule of Law and Control of Corruption from the World Bank's Governance indicators, the Corruption Perception

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[13] Higher lags were not statistically significant.
[14] For parsimony results are not reported in the tables.
[15] Regulatory variables derive from Barth et al.(2008) and are constructed on data fromWorld Bank's Bank Regulation Survey 2008 and 2012

index from Transparency International along the line of Beck et al. (2006) who find a positive relation between bank officer's corruption and biased lending policies that can only partially be mitigated by supervisors. In addition we check for the relevance of financial market development by including the natural logarithm of the sum of Private Credit and Market Capitalization divided by GDP, the ratio between (Demand, Time and Saving) deposits and GDP and the banking sector's default risk (z-score), whose values are taken from Beck et al.(2009).[16] Finally we test for the significance of two measures of Bank Concentration - respectively the assets of the three and the five largest commercial banks as a share of total commercial banking assets[17]- as risk taking incentive for banks are usually higher as their markets become more concentrated (e.g. Boyd et al. 2005). None of these variables is significant when added to our model and our main results are not affected.

5.2 ***Internal Rating Models and RWA***

As part of the robustness analysis, in this section we study the relation between bank characteristics and internal risk models for a subset of banks in our sample. Here we focus on the percentage of credit EAD modelled by banks through internal models (we call such a variable IRBA). IRBA has two advantages: first it is a direct result of the efforts of banks to use internal models and second it is limited to credit risk and does not also include other sources of risk (e.g. market risk and operational risk) that may affect the density. We are able to measure the variable from the Pillar III reports of 86 international banks located in countries adopting Basle II.

[Insert Table 8 around here]

The results in panel A, with IRBA as the dependent variable, are consistent with our previous findings and confirm the importance of the bank-level explanatory variables used in the analysis. Signs are as expected and are reversed with respect to the ones reported in table 4, coherently with the definition of the new dependent variable.

[16] On data from the World Bank's Financial Structure database September 2012.
[17] Source the World Bank's Global Financial Development database 2012.

In table 8, panel B, we show the panel estimation with fixed country and year effects explaining the RWTA for the subgroup of 86 banks on the basis of bank-level explanatory variables and the percentage of EAD weighted via internal rating models. Results are as expected. A larger share of EAD evaluated with internal rating models is associated with a lower RWA density. All the remaining variables keep the statistical significance and sign as in the previous analyses.

5.3 ***RWA optimization and banks' resilience***

Finally we ask whether a reduction of RWA via optimization has affected bank's resilience and performance during the recent bank crisis. The estimates of equation 3 in table 4 are used to compute a measure of the reduction in RWTA due to bank's cost of capital, i.e. our RWA optimization proxy. Using the property that - in a linear regression - the average value of the dependent variable is the sum of the estimated coefficient multiplied by the average of the correspondent explicative variables (including the constant), we compute the level importance (Achen 1982 p.72) to obtain the average amount of RWTA density reduction via optimisation actions under the Basle 2 framework. The average amount of optimisation turns out to be around 6% of bank RWTA[18].

The same idea may be applied to derive a proxy for each bank-year observation (BETA OPT) which represents the reduction of RWTA due to optimization (high degrees of optimization corresponding to large positive values).

[Insert Table 9 around here]

Panel A in Table 9 shows the estimates of a panel OLS where the dependent variable (ROAE) is regressed against BETA OPT and other control variables. In all cases, over the full sample and during times of crisis, the RWA optimization produces a negative effect on bank's performance. This result could be due to a biased valuation of risks that alters the profitability prospects and is robust to the introduction of bank's level control variables, including the cost of

[18] This is obtained by the product of (0.0422) –see column 3 Table 4- by the average value of beta*bas (0.97) divided by the average RWTA (0.64)

capital BETA (see equation 3 in Table 9). This finding is preliminary but holds true also when we consider as dependent variable the ratio between net income and total assets[19]. Despite the need for further analyses, this suggests that risk weight optimization have a null short run impact of profitability.

In Panel B, a Probit model - over the sample period 2007-2009, corresponding to the credit crisis – provides estimates of the effect of BETA OPT and other bank-control variables on the likelihood of an increase of equity capital. The dependent variable is a dummy named CAPITAL INCREASE that is equal to 1 when the number of shares in the year changes at least by 10%. The proxy BETAOPT affects the capital increase outcome with a positive sign. This means that the higher the level of RWA optimization the higher the likelihood of capital increases during time of distress. IMPLGL is always significant with a positive sign, which can be reasonably associated to a worsening of bank's resilience to shocks due to a deterioration of the loan portfolio. The relevance of the proxy of RWA optimization and of the share of impaired loans is also detected by the margins[20] computed at the mean level. All the remaining control variables do not display any statistical significance.

6. **Conclusions**

We show that the cost of equity capital is a relevant factor in risk weights optimization. This holds under several econometric specifications, and considering several bank and country characteristics that are believed to represent objective sources of heterogeneity in the choice of risk weights. Our findings open the possibility that the international playing field is not level which may be an unintended consequence of the flexibility allowed by regulators to use the large information sets locally available to banks in order to better determine their risks. Moreover, it also raises the question of whether stock market investors understand the result of this optimization process. If the

[19] Estimates are not reported here for parsimony but are available upon request to the authors.
[20] The margins are the estimates of the marginal probability effects of the explanatory variables .

available public information does not allow them to understand it, then questions should be raised about the effectiveness of the current disclosure arrangements. On the other hand, if investors do account for different risk weights, then stock prices may incorporate the possibility that bank capital is less than what one would deduce from the official tier one ratio. This would imply that studies regarding capital in banking would better use a measure of tangible equity rather than the tier one ratio.

The ultimate impact of the risk weighting system on banks and the economy at large is a fascinating topic. The risk weighting system may well affect business choices of banks, for example by inducing them to over-invest in low-risk weight assets like real estate and government debt. If there are macroeconomic crises associated with the emergence of unforeseen risks in the assets the banks have over-invested into, then there is potentially negative relation between indicators of risk that are set by the regulators and the riskiness of banks. This negative relation could be due to errors in determining risk weights, e.g. regulators suffering from behavioural biases and not looking at the long run experience revealed by the data, and/or new risks exogenously appearing in ways that are unrelated to historical experience, and/or to an endogenous mechanism by which low risk weights allow excess capital to flow into a sector and as a consequence relax discipline among agents in that sector and finally build up risks. In this paper we do not consider such links and limit ourselves to understanding whether the system may have unintended consequences on the management of banks. We raise the possibility that RWA optimization may be bad for profits and may induce banks to work with too little capital in normal times and may force banks to raise capital in bad times. However, these results are only suggestive of further studies that should see RWA optimization as part of a bigger picture that also looks at macroeconomic instability.

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Appendix A: Distribution of banks by country and correspondent local equity index

This table reports the number of banks per countries, the list of countries and the local equity index used for the computation of the variable BETA.

Country	n. of banks	Local Equity Index	Country	n. of banks	Local Equity Index
ARGENTINA	2	ARGENTINA BURCAP	KOREA REP. OF	7	KOREA SE COMPOSITE (KOSPI)
AUSTRALIA	9	ASX ALL ORDINARIES	LUXEMBOURG	1	LUXEMBOURG SE LUXX
AUSTRIA	7	WIENER BOERSE INDEX (WBI)	MALAYSIA	10	FTSE BURSA MALAYSIA KLCI
BELGIUM	2	BEL 20	MALTA	2	MALTA SE MSE
BRAZIL	13	BRAZIL BOVESPA	MEXICO	4	MEXICO IPC (BOLSA)
CANADA	8	S&P/TSX COMPOSITE INDEX	NETHERLANDS	4	AEX INDEX (AEX)
CHILE	4	CHILE SANTIAGO SE GENERAL (IGPA)	NORWAY	17	OSLO SE OBX
CHINA-PEOPLE'S REP.	11	SHANGHAI SE A SHARE	PHILIPPINES	11	PHILIPPINE SE I(PSEi)
COLOMBIA	3	COLOMBIA IGBC INDEX	POLAND	9	WARSAW GENERAL INDEX 20
CYPRUS	2	CYPRUS GENERAL	PORTUGAL	5	PORTUGAL PSI-20
CZECH REPUBLIC	1	PRAGUE SE PX	ROMANIA	3	ROMANIA BET (L)
DENMARK	19	OMX COPENHAGEN BMARK (OMXCB)	RUSSIAN FEDERATION	14	RUSSIAN MICEX INDEX
FINLAND	2	OMX HELSINKI (OMXH)	SINGAPORE	2	STRAITS TIMES INDEX L
FRANCE	7	SBF 120	SOUTH AFRICA	4	FTSE/JSE ALL SHARE
GERMANY	10	DAX 30 PERFORMANCE	SPAIN	11	IBEX 35
GREECE	9	ATHEX COMPOSITE	SWEDEN	4	OMX AFFARSVARLDENS GENERAL
HONG KONG	4	HANG SENG	SWITZERLAND	4	SWISS MARKET (SMI)
INDIA	15	INDIA BSE (100) NATIONAL	THAILAND	4	BANGKOK S.E.T.
INDONESIA	5	IDX COMPOSITE	TURKEY	9	ISTANBUL SE NATIONAL 100
IRELAND	4	IRELAND SE OVERALL (ISEQ)	UNITED ARAB EMIRATES	17	ADX GENERAL
ISRAEL	6	ISRAEL TA 100	UNITED KINGDOM	7	FTSE ALL SHARE
ITALY	18	FTSE ITALIA ALL SHARE	USA	231	S&P 500 COMPOSITE
JAPAN	7	TOPIX			
n. of countries	45		n. of banks	548	

Appendix B: Variables definition and data sources

This table provides the definition of the variables used in this study and their data source. Panel A describes the bank-level variables and Panel B the country-level variables.

Acronym	Description	Source
PANEL A		
RWTA	Bank's total risk weighted assets on bank's total assets	Our computation on Bankscope raw data
A	Dummy variable whose value is 1 when the bank adopts the IFRS accounting standard and takes the value 0 otherwise	Bankscope
BETA	Beta estimated at bank-level through a CAPM regression with respect to the local equity index	Our computation on Datastream data
BETA*BAS	Product between Beta and Dummy Basle 2	Our computation On Bloomberg database and Datastream
BETA OPT	Proxy of RWA optimization according to estimates in table 4 (see section 5.3)	Our computation
BAS	Dummy variable whose value is 1 when the bank's headquarter is located in a country that adopts the Basle2 supervisory regime and takes the value 0 otherwise	BIS an 2012 World Bank survey on Bank regulation
CAPITAL INCREASE	Dummy variable equal to 1 when the number of shares in the year changes at least by 10% and takes the value of 0 otherwise	Our computation on Datastream raw data /Thompson Reuters
DLOTAF	First difference of the ratio of bank's total loans to bank's total assets one period ahead	Our computation on Bankscope raw data
EQTA	Ratio of total equity on total assets (in percentage)	Our computation on Bankscope raw data
FRAGILITY	Deposits from other banks, other deposits and short-term borrowing to total deposits plus money market and short-term funding, as in Beltratti Stulz (2012)	Our computation on Bankscope raw data
IMPLGL	Ratio impaired loans on gross loan (in percentage)	Our computation on Bankscope raw data
IRBA	Percentage of credit EAD modeled by banks through internal models	Banks Annual Reports
LGZ	Z score computed as the average bank return on asset plus bank equity to assets ratio scaled by the standard deviation of return on assets over a five-year rolling window. Higher z score indicate lower bank risk. We use the natural logarithm of zscore because its distribution is highly skewed (in percentage)	Our computation on Bankscope raw data
LTA	Natural log of total assets	Our computation on Bankscope raw data
LOTA	Total bank's loan to bank's total assets	Our computation on Bankscope raw data
NIM	Net interest margin the ratio of the difference between the total interest income and cost of – interest expenses related to - the funds used for making loans and investments on the average interest bearing assets	Our computation on Bankscope raw data
P/B	Bank's price to book value	Bankscope
ROAE	Average return on equity (in percentage)	Bankscope
TEQTA	Tangible equity (total equity-goodwill) to total assets	Our computation on Bankscope raw data
T1RATIO	Bank's core capital to total risk weighted assets	Bankscope
PANEL B		
CREDITOR RIGHTS	An index aggregating creditor rights. It ranges between 0 and 4 over the period of 1978– 2003. It is the sum of the four indexes that follow**:** restrictions on reorganization that equals 1 if the reorganization procedure imposes restrictions and 0 otherwise; no automatic stay that equals 1 if there is no imposition of an	La Porta, Lopez-de-Silanes, Shleifer, and Vishny(1998), Djankov, McLiesh, and Shleifer(2007)

	automatic stay on the assets upon filing the petition and creditors are able to seize their collateral after the petition is approved and 0 otherwise; secured creditor paid first that equals 1 if secured creditors are ranked first in the distribution of the proceeds of a bankruptcy as opposed to other creditors 0 otherwise; no management stay that equals 1 if an official appointed by the court or by the creditors, is responsible for the operation of the business during reorganization and 0 otherwise	
COMMON LAW	Dummy variable that takes value 1 when the country has common law as legal origin	Djankov, McLiesh, and Shleifer(2007)
EDF	Average expected default frequency of the domestic corporate sector (not financial)	KMV Moody's Database
FINANCIAL FREEDOM	An indicator of relative openness of banking & financial system. The index ranges in value from 0 (very low) to 100 (very high). It reflects the government ownership of financial institutions, restrictions on the ability of foreign banks to open branches and subsidiaries, government influence over the allocation of credit; government regulations	Heritage Foundation's Index of Economic Freedom
LEGAL RIGHTS	The index measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate the lending . the index ranges from 0 to 10 the higher values indicate that these laws are better designed to expand access to credit	World bank Doing Business Indicators 2005-2012
LT GOV RATE	Nominal interest rate on long term Government bond	IMF IFS, various issues
OFFICIAL	Index of the power of the commercial bank supervisory agency, including the rights of the supervisor to meet with and demand information from auditors, to force a bank to change the internal organizational structure, to supersede the rights of shareholders, and to intervene in a bank	World Bank Survey on Bank Regulation and Surpervisory 2008 and 2012
RECOVERY	Cents on the dollar recouped by creditors through reorganization, liquidation or debt enforcement (foreclosure) proceedings. It is a present value based on end-of period lending rates from the International Monetary Fund	World bank Doing Business Indicators 2005-2012

Table 1. Descriptive statistics RWTA

This table presents the summary statistics for the dependent variable, defined as the ratio of RWA to total assets, for the full sample of banks and for both banks located in countries adopting the Basle 2 framework and for banks located in countries that do not adopt the Basle 2 framework. The number of observation indicates the total number of firm-year observations.

RWTA	obs	mean	stdev
Full sample	2420	0.6458	0.1714
Subgroup Basle2	1416	0.6053	0.1820
Subgroup no Basle2	1004	0.7029	0.1361
	t value		
t test of different mean in subgroups	-15.09		

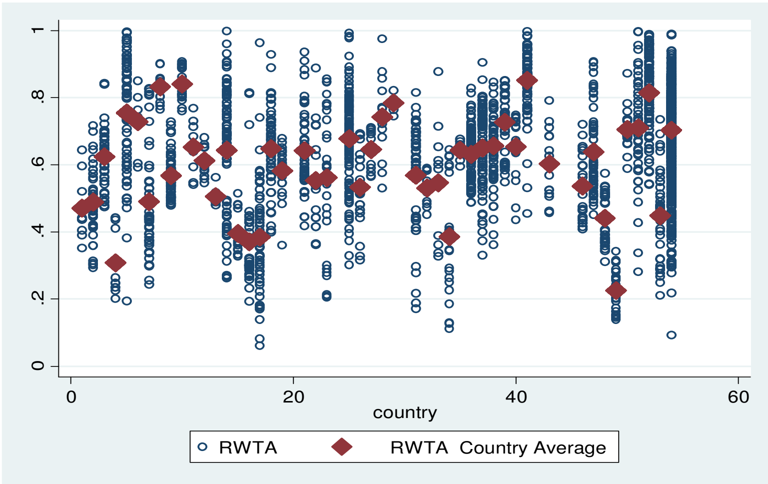
Table 2. Descriptive Statistics

This table reports the descriptive statistics of all the explicative variables. Panel A reports summary statistics for bank level variables. Panel B reports summary statistics for the country-level variables. See Appendix B for a detailed description.

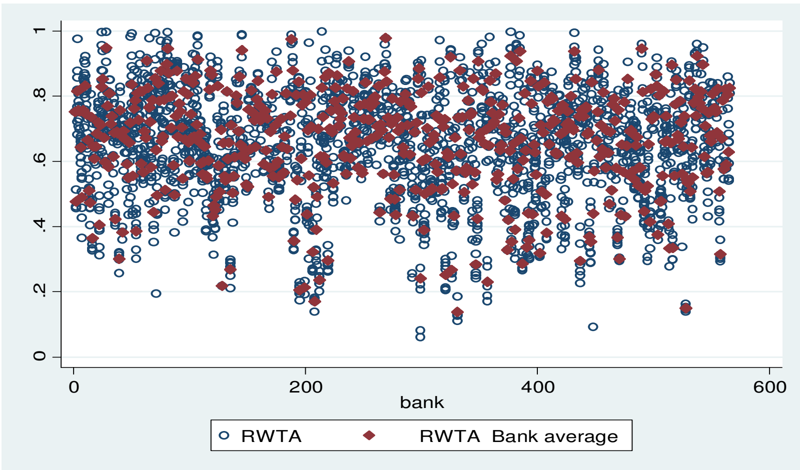
Panel A	***Bank- Level Variables***			
Variable	**Obs**	**Mean**	**Median**	**Std. Dev.**
A	2420	0.5525	1	0.4973
BETA	1701	0.9598	0.9767	0.4902
BETA *BAS	1701	0.6178	0.6438	0.5777
BAS	2420	0.6079	1	0.4883
DLOTA	2086	0.0038	-0.0033	0.1232
EQTA	2350	8.3437	7.6331	4.4124
FRAGILITY	2279	17.1413	11.5194	17.4806
IMPL/GL	2202	4.3697	3.0115	4.3534
LGZ	2332	3.1812	3.2128	0.9775
LOTA	2346	0.6066	0.6342	0.1601
LTA	2350	16.6580	16.3648	2.1750
NIM	2350	3.0010	2.8869	1.6823
P/B	1957	1.1748	0.9870	0.8489
ROAE	2342	7.1423	10.1750	17.5909
TEQTA	1995	7.1997	6.5788	3.8864
T1RATIO	2305	12.2182	11.2000	5.2447

Panel B	***Country-level Variables***			
CREDITOR RIGHTS	2000	1.6930	1.0000	1.0988
COMMON LAW	2420	0.4793	0.0000	0.4997
EDF	1937	0.8083	0.3700	1.7201
FINANCIAL FREEDOM	2391	64.2283	70.0000	16.8844
LEGAL RIGHTS	2413	6.9453	8.0000	2.4167
LT GOV RATE	2175	5.9444	4.0700	6.9862
OFFICIAL	2369	9.5129	10.0000	1.8924
RECOVERY	2408	60.5555	75.4000	25.4056

Panel A Heterogeneity across country



Panel B Heterogeneity across banks



Panel C Heterogeneity across years

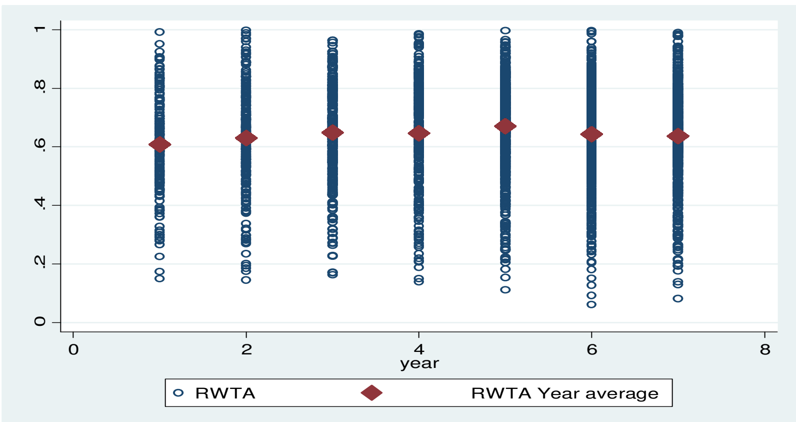


Figure 1 Risk Weighted Asset Density

This figure plots the dispersion of the dependent variable RWTA with respects to banks, countries and years.

Table 3. Correlations matrixes

The table presents pairwise correlations of the variables. The sample consists of banks located in 45 countries across the 2005-2011 time period. All variables are defined in Appendix B. Panel A refers to bank-level variables. Panel B refers to country-level variables. * represents significance at 5% level.

Panel A	A	BETA	BETA*BAS	BAS	DLOTA	EQTA	FRAGILITY	IMPLGL	LGZ	LTA	LOTA	NIM	PB	ROAE	TEQTA	T1RATIO
A	1															
BETA	0.0250	1														
BETA*BAS	0.5654*	0.3262*	1													
BAS	0.6014*	0.0737*	0.8228*	1												
DLOTA	0.1061*	0.0655*	0.1510*	0.1308*	1											
EQTA	-0.1369*	-0.1338*	-0.2328*	-0.1480*	0.1267*	1										
FRAGILITY	0.3225*	0.0824*	0.3381*	0.3123*	0.0336	-0.1266*	1									
IMPLGL	0.0554*	0.1096*	0.1263*	0.0765*	-0.0583*	0.1057*	0.0338	1								
LGZ	0.0631*	-0.3284*	-0.0163	0.0851*	0.0064	0.0954*	-0.0784*	-0.3462*	1							
LTA	0.3753*	0.3508*	0.5146*	0.3398*	0.0363	-0.3610*	0.3081*	-0.1870*	0.0573*	1						
LOTA	-0.0183	-0.1064*	-0.1160*	-0.0855*	0.0252	-0.0126	-0.1759*	-0.0254	0.0765*	-0.2728*	1					
NIM	-0.3255*	-0.0829*	-0.4051*	-0.3667*	0.0522*	0.5151*	-0.2622*	0.2059*	-0.0492*	-0.4447*	0.1910*	1				
PB	0.1525*	-0.1305*	0.0484	0.1231*	0.1119*	0.1115*	0.0385	-0.2420*	0.2587*	0.0979*	-0.1078*	0.0433	1			
ROAE	0.1566*	-0.1632*	0.0784*	0.1297*	0.1327*	0.2290*	-0.0506*	-0.3831*	0.4358*	0.1524*	-0.0784*	0.1082*	0.3795*	1		
TEQTA	-0.1832*	-0.1268*	-0.2082*	-0.1349*	0.1413*	0.9515*	-0.1351*	0.1035*	0.0918*	-0.4216*	-0.0392	0.5390*	0.1126*	0.2359*	1	
T1RATIO	-0.1956*	-0.0509*	-0.1849*	-0.1325*	0.0643*	0.7117*	-0.0344	0.1128*	-0.0293	-0.3221*	-0.2547*	0.3340*	0.0433	0.1153*	0.7009*	1

Panel B	CREDITOR RIGHTS	COMMON LAW	EDF	FINANCIAL FREEDOM	LEGAL RIGHTS	LT GOV RATE	OFFICIAL	RECOVERY
CREDITOR RIGHTS	1							
COMMON LAW	-0.1524*	1						
EDF	0.2594*	-0.2178*	1					
FINANCIAL FREEDOM	-0.3363*	0.4130*	-0.2445*	1				
LEGAL RIGHTS	0.0157	0.6721*	-0.2084*	0.6342*	1			
LT GOV RATE	-0.1132*	-0.1837*	0.1418*	-0.2251*	-0.3493*	1		
OFFICIAL	-0.2766*	0.2887*	-0.2070*	0.2977*	0.2198*	0.2028*	1	
RECOVERY	-0.1696*	0.3652*	-0.2669*	0.6879*	0.6200*	-0.4948*	0.0728*	1

Table 4 Baseline RWTA panel OLS estimations with fixed country effects

This table presents estimates from the $d_{i,j,t} = \beta_1 CC_{i,t-1} + \beta_2 RC_{i,t-1} + \beta_3 BM_{i,t-1} + \beta_4 CE_{j,t-1} + \varepsilon_{i,j,t}$ RWTA regression , where $d_{i,j,t}$ is the RWA density, *i* indexes the bank, *j* indexes the country and *t* denotes the year. CC is the cost of capital (BETA), RC is the benefit of capital (PB), BM is the business model (NIM) and CE are the country effects, here assumed to be fixed. See Appendix B for variable definitions. Robust standard errors are used to compute the Student-*t*. ***** , **** and * represent statistical significance at the 1%, 5% and 10% level respectively. All the explicative variables are lagged by one period .

	1			2			3			4			5		
main structure	Coef.	t		Coef.	t		Coef.	t		Coef.	t		Coef.	t	
NIM	0.0392	8.44	***	0.0347	7.18	***	0.0312	6.45	***	0.0306	6.27	***	0.0237	4.55	***
BETA	0.0002	0.02		0.0014	0.15		0.0116	1.15		0.0078	0.75		0.0107	1.01	
BETA*BAS	-0.0475	-2.92	***	-0.0440	-2.70	***	-0.0422	-2.62	***	-0.0385	-2.40	**	-0.0288	*-1.70*	*
PB	-0.0132	-2.48	**	-0.0145	-2.70	***	-0.0125	-2.28	**	-0.0130	-2.28	**	-0.0098	*-1.69*	*
ROAE															
DLOTAF															
A	-0.0876	-2.63	***	-0.0840	-2.51	**	-0.0803	-2.55	**	-0.0967	-2.91	***	-0.0575	-1.21	
BAS	-0.0164	-0.92		-0.0187	-1.11		-0.0109	-0.70		-0.0117	-0.74		0.0812	1.40	
control variable															
EQTA				0.0057	3.51	***	0.0054	3.33	***	0.0056	3.37	***	0.0057	3.33	***
LTA							-0.0081	-3.26	***	-0.0074	-2.91	***	-0.0064	-2.37	**
LGZ										-0.0059	-1.21		-0.0038	-0.75	
IMPLGL													0.0006	0.43	
CONSTANT	0.8522	20.10	***	0.7890	17.13	***	0.9126	16.08	***	0.9318	16.02	***	0.7787	12.86	***
Year fixed effects	YES			YES			YES			YES			YES		
Country fixed effects	YES			YES			YES			YES			YES		
obs	1326			1326			1326			1283			1207		
R2 adjusted	0.508			0.516			0.521			0.521			0.521		

Table 5 RWTA panel OLS estimations with country-level variables

This table presents estimates from the RWTA regression $d_{i,j,t} = \beta_1 CC_{i,t-1} + \beta_2 RC_{i,t-1} + \beta_3 BM_{i,t-1} + \beta_4 CE_{j,t-1} + \varepsilon_{i,j,t}$ where $d_{i,j,t}$ is the RWA density, i indexes the bank, j indexes the country and t denotes the year. CC is the cost of capital (BETA), RC is the benefit of capital (PB), BM is the business model (NIM) and CE are the country level variables. See Appendix B for variables details. Robust standard errors are used to compute the Student-*t*. *****,** ** and * represent statistical significance at the 1%, 5% and 10% level respectively. All the explicative variables are lagged by one period .

	1		2		3		4		5		6		7	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
Main structure														
NIM	0.0410	7.73 ***	0.0405	7.46 ***	0.0428	7.24 ***	0.0384	6.74 ***	0.0406	7.35 ***	0.0364	6.45 ***	0.0405	7.42 ***
BETA	0.0217	2.09 **	0.0206	1.98 **	0.0206	1.98 **	0.0191	1.81 *	0.0206	1.98 **	0.0190	1.83 *	0.0208	1.99 **
BETA*BAS	-0.0614	-3.27 ***	-0.0749	-3.95 ***	-0.0761	-3.98 ***	-0.0745	-3.91 ***	-0.0751	-3.92 ***	-0.0716	-3.82 ***	-0.0799	-4.15 ***
PB	-0.0274	-3.99 ***	-0.0290	-4.08 ***	-0.0293	-4.04 ***	-0.0303	-4.27 ***	-0.0291	-4.06 ***	-0.0273	-3.87 ***	-0.0294	-4.10 ***
A	0.0182	1.33	-0.0002	-0.01	-0.0042	-0.26	0.0029	0.19	0.0008	0.05	-0.0186	-1.22	0.0087	0.51
BAS	0.0202	0.86	0.0308	1.18	0.0384	1.43	0.0197	0.74	0.0318	1.16	0.0065	0.24	0.0257	0.93
Control variables														
EQTA	0.0068	3.65 ***	0.0053	2.79 ***	0.0053	2.75 ***	0.0048	2.50 **	0.0054	2.81 ***	0.0040	2.06 ***	0.0052	2.75 ***
LTA	-0.0123	-4.80 ***	-0.0122	-4.61 ***	-0.0118	-4.28 ***	-0.0122	-4.59 ***	-0.0122	-4.57 ***	-0.0135	-5.05 ***	-0.0123	-4.61 ***
Country variables														
EDF	0.0093	2.27 **	0.0144	3.99 ***	0.0152	4.16 ***	0.0122	3.25 ***	0.0145	4.01 ***	0.0092	2.46 **	0.0162	4.33 ***
OFFICIAL	0.0097	3.25 ***	0.0105	3.45 ***	0.0106	3.49 ***	0.0103	3.36 ***	0.0106	3.42 ***	0.0075	2.36 **	0.0104	3.34 ***
CREDITOR RIGHTS			0.0009	0.19	-0.0003	-0.06	0.0024	0.48	0.0008	0.15	0.0097	1.81 *	0.0007	0.15
LT GOV RATE					-0.0010	-0.76								
RECOVERY							-0.0004	-1.72 *						
COMMON LAW									0.0020	0.16				
LEGAL RIGHTS											-0.0122	-4.24 ***		
FINANCIAL FREEDOM													0.0000	0.09
CONSTANT	0.5851	11.22 ***	0.5877	10.75 ***	0.5769	10.05 ***	0.6336	10.74 ***	0.5844	9.74 ***	0.7598	10.48 ***	0.5886	8.73 ***
Year fixed effects		YES		YES		YES		YES		YES		YES		YES
Obs		1069		999		984		999		999		999		984
R2 Adj		0.35		0.38		0.37		0.39		0.38		0.39		0.38
n .of country		43		36		36		36		36		36		35

Table 6 RWTA dynamic system GMM

This table presents estimates from the RWTA regression of the type $d_{i,j,t} = \alpha d_{i,j,t-1} + \beta_1 CC_{i,t} + \beta_2 RC_{i,t} + \beta_3 BM_{i,t} + \beta_4 CE_{j,t} + \gamma_j + \mu_t + \varepsilon_{i,j,t}$ where $d_{i,j,t}$ is the RWA density, *i* indexes the bank, *j* indexes the country and *t* denotes the year. CC is the cost of capital (BETA), RC is the benefit of capital (PB), BM is the business model (NIM) and CE are the country-level variables, γ_j and μ_t denote sets of country dummies and time effects and $\varepsilon_{i,j,t}$ is the error term . See Appendix B for variables details. One step robust standard errors are used to compute the Student-*t*. *** **,** ** and * represent statistical significance at the 1%, 5% and 10% level respectively. All instruments are collapsed, all bank-level variable are treated as predetermined; all country-level variables are treated as strictly exogenous.

	1		2		3		4		5		6	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t
Main structure												
RWTA(t-1)	0.6279	9.64 ***	0.5828	8.40 ***	0.6648	10.84 ***	0.6297	9.12 ***	0.6361	9.25 ***	0.6779	10.91 ***
NIM	0.0275	2.95 ***	0.0321	4.01 ***	0.0315	4.21 ***	0.0287	3.50 ***	0.0296	3.52 ***	0.0311	3.67 ***
BETA	0.0740	4.12 ***	0.0619	2.53 **	0.0678	2.74 ***	0.0664	2.41 **	0.0663	2.68 ***	-0.0766	-2.06 **
BETA*BAS	-0.0820	-2.87 ***	-0.0640	-1.71 *	-0.0707	-1.96 **	-0.0671	-1.75 *	-0.0671	-1.85 *	-0.0782	-2.04 **
PB	-0.0167	-1.75 *	-0.0296	-2.79 ***	-0.0242	-2.15 **	-0.0318	-2.58 ***	-0.0292	-2.46 **	-0.0250	-2.21 **
A	0.0840	1.17	0.0444	2.48 **	0.0401	2.03 **	0.0626	2.93 ***	0.0530	2.69 ***	0.0315	1.63
BAS	0.3955	2.48 **	0.0633	1.40	0.1091	2.32 **	0.0787	1.75 *	0.0898	2.06 **	0.1094	2.76 ***
Control variables												
EQTA	0.0058	1.51	0.0055	1.28	0.0076	1.62	0.0052	1.21	0.0058	1.35	0.0070	1.55
LTA	-0.0202	-2.70 ***	-0.0090	-2.95 ***	-0.0161	-3.48 ***	-0.0114	-2.65 ***	-0.0139	-3.00 ***	-0.0173	-2.91 ***
Country variables												
EDF			0.0048	2.08 **	0.0066	1.85 *	0.0048	2.05 **	0.0063	1.88 *	0.0061	1.47
OFFICIAL			0.0183	2.71 ***	0.0143	2.70 ***	0.0171	2.83 ***	0.0163	3.24 ***	0.0109	2.66 ***
CREDITOR RIGHTS			0.0156	2.81 ***	0.0115	1.91 *	0.0112	2.05 **	0.0081	1.35	0.0129	2.07 **
RECOVERY					0.0010	2.08 **						
COMMON LAW							0.0426	1.65 *				
LEGAL RIGHTS									0.0086	1.90 *		
FINANCIAL FREEDOM											0.0019	2.14 **
Year fixed effects	YES		YES		YES		YES		YES		YES	
Country fixed effects	YES											
SE clustered at country level			YES		YES		YES		YES		YES	
obs	1172		964		964		964		964		949	
n instrument	99		57		58		58		58		58	
n.group	348		318		318		318		318		314	
ratio	3.52		5.58		5.48		5.48		5.48		5.41	
AB test AR1	0.00		0.00		0.00		0.00		0.00		0.00	
AB test AR2	0.14		0.93		0.85		0.75		0.94		0.84	
Hansen J pvalue	0.75		0.97		0.99		0.97		0.99		0.99	
Diff in Hansen test of exogeneity p value	0.83		0.99		0.67		0.99		0.94		0.96	
number of country	45		36		36		36		36		35	

Table 7 Robustness check

Baseline RWTA panel OLS estimations with fixed country effects with RC proxied alternatively by the ROAE and by the forward percentage change of the ratio of loan to total assets (DLOTAF). All variable definitions are in Appendix B. Robust standard errors are used to compute the Student-*t*. *** , ** and * represent statistical significance at the 1%, 5% and 10% level respectively. All the explicative variables are lagged by one period .

	PANEL OLS						PANEL IV GMM					
	1			2			3			4		
main structure	Coef.	t		Coef.	t		Coef.	t		Coef.	t	
NIM	0.0277	6.83	***	0.0266	6.57	***	0.0263	5.88	***	0.0262	5.85	***
BETA	0.0093	0.94		0.0110	1.09		0.0274	2.34	**	0.0255	2.05	**
BETA*BAS	-0.0307	-1.99	**	-0.0298	-1.95	*	-0.0471	-2.29	**	-0.0455	-2.24	**
ROAE	-0.0005	-1.97	**	-0.0005	*-1.78*	*						
DLOTAF							-0.4700	-2.53	**	-0.4584	-2.44	**
A	-0.0744	-2.88	***	-0.0827	-2.99	***	-0.1016	-2.63	***	-0.1018	-2.68	***
BAS	-0.0112	-0.82		-0.0095	-0.70		0.0083	0.49		0.0071	0.41	
control variable												
EQTA	0.0050	3.67	***	0.0049	3.58	***	0.0061	3.69	***	0.0062	3.77	***
LTA	-0.0074	-3.08	***	-0.0075	-3.07	***	-0.0069	-2.42	**	-0.0068	-2.39	**
LGZ				0.0021	0.43					-0.0023	-0.43	
CONSTANT	-0.5229	-15.56	***	0.8934	16.37	***	0.9249	13.76	***	0.9318	13.68	***
Year fixed effects		YES			YES			YES			YES	
Country fixed effects		YES			YES			YES			YES	
obs		1488			1435			969			968	
R2 adjusted		0.545			0.544			0.556			0.559	

Table 8. Relevance of the internal rating models

Panel A presents the Tobit estimates for the percentage of EAD evaluated with internal rating models. Panel B reproduces the regressions in table 4 for the sample of 86 banks adding as explicative variable the percentage of EAD modelled through internal models. All variable definitions are in Appendix B. Standard errors are robust and clustered in years. *** , ** and * represent statistical significance at the 1%, 5% and 10% level respectively All the explicative variables are lagged by one period.

Panel A : Tobit regression, dependent variable IRBA

	1			2			3		
	Coef.	t		Coef.	t		Coef.	t	
BETA	0.1979	18.72	***	0.2061	4.18	***	0.1914	7.09	***
PB				0.1224	2.45	**	0.1700	3.54	***
NIM							-0.0927	-6.6	***
EQTA							-0.0578	-3.5	***
LTA							-0.0124	-0.6	
CONSTANT	6E+06	11.76	***	4E+06	2.82	***	1.02758	2.04	**
Country fixed effects		YES			YES			YES	
no.country		27			27			26	
no.obs		263			237			233	
Pseudo R2		0.46			0.55			0.60	

Panel B: Panel OLS , dependent variable RWTA

	1			2		
	Coef.	t		Coef.	t	
IRBA	-0.0806	-4.78	***	-0.0472	-5.36	***
BETA				-0.0499	-4.26	***
PB				0.0219	1.58	
NIM				0.0502	4.76	***
EQTA				0.0127	2.70	***
LTA				-0.0482	-7.73	***
CONSTANT	0.5539	11.8	***	1.0276	2.04	**
Country fixed effects		YES			YES	
no.country		27			24	
no.obs		225			160	
R2 adj		0.72			0.87	

Table 9. The impact of RWA optimization on bank's resilience

In this table, Panel A presents the panel OLS regression analysis of the return on average equity on the proxy of RWA optimization (BETA OPT) and on other bank-level characteristics both over the full sample and in the crisis period. Standard errors are robust and clustered at country level. Panel B shows the estimates of a Probit regression for the likelihood of a CAPITAL INCREASE on the proxy of RWA optimization (BETA OPT) and other bank-level variables. Standard error are robust, margins are the estimates of the marginal probability effects of the explanatory variables and are computed at the mean level. EQTA is lagged by one period. All the variables are defined in Appendix B. *** , ** and * represent statistical significance at the 1%, 5% and 10% level respectively.

Panel A. Panel OLS, dependent variable ROAE

	1				2				3				4				5			
	Full sample		2007-2009		Full sample		2007-2009		Full sample		2007-2009		Full sample		2007-2009		Full sample		2007-2009	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef.	t	Coef	t	Coef.	t
BETA OPT	-36.13	-2.35 **	-96.04	-2.38 **	-55.80	-3.71 ***	-107.25	-2.57 ***	-25.08	-0.87	-122.27	-5.46 ***	-41.99	-2.51 **	-113.67	-2.61 ***	-27.40	-1.36	-107.63	-2.63 ***
IMPLGL					-1.77	-1.42	-0.53	-1.96 **	-1.73	-1.45	-0.53	-2.09 **	-1.90	-1.45	-0.47	-1.83 *	-1.96	-1.52	-0.50	-1.89 *
BETA									-9.19	-1.11	3.92	1.06								
LTA													-1.11	-1.27	0.43	0.80	0.52	0.71	1.10	1.47
EQTA																	1.71	1.52	0.65	1.43
CONSTANT	-1.44	0.13	12.35	4.94 ***	9.57	2.24 **	15.76	6.63 ***	16.76	4.37 ***	13.24	4.84 ***	28.36	2.22 **	8.35	0.88	-14.65	-0.64	-8.07	-0.54
Year fixed effects		YES		YES		YES		YES		YES		YES		YES		YES		YES		YES
Cluster country		YES		YES		YES		YES		YES		YES		YES		YES		YES		YES
no.country		37		32		37		32		37		32		37		32		37		32
no.obs		844		394		771		367		771		367		771		367		771		367
R2 adj		0.03		0.12		0.05		0.14		0.05		0.14		0.05		0.13		0.06		0.14

Panel B. Probit regression, dependent variable CAPITAL INCREASE sample (2007-2009)

	1			2			3			4			5			6		
	Coef.	z		Coef.	z		Coef.	z		Coef.	z		Coef.	z		Coef.	z	
BETA OPT	3.78	2.35	**	5.01	2.92	***	4.59	2.46	**	4.58	2.45	**	4.58	2.43	**	4.43	2.23	**
margin	0.22	11.87	***	0.23	11.53	***	0.23	11.46	***	0.23	11.46	***	0.23	11.47	***	0.23	11.41	***
IMPLGL				0.04	1.82	*	0.04	1.89	*	0.04	1.86	*	0.04	1.75	*	0.04	1.86	*
margin				0.22	11.33	***	0.22	11.33	***	0.22	11.33	***	0.22	11.34	***	0.22	11.33	***
LTA							0.03	0.60		0.03	0.57		0.02	0.29		0.03	0.56	
NIM										-0.01	-0.13		0.01	0.10		-0.01	-0.11	
EQTA													-0.01	-0.52				
RWTA																-0.11	-0.15	
CONSTANT	-1.07	-3.17	***	-1.18	-3.31	***	-1.77	-1.59		-1.73	-1.47		-1.42	-1.11		-1.66	-1.26	
Year fixed effects		YES			YES			YES			YES			YES			YES	
Country fixed effects		YES			YES			YES			YES			YES			YES	
no.country		37			36			36			36			36			36	
no.obs		464			412			412			412			409			412	
Prob> chi2		0.00			0.00			0.00			0.00			0.00			0.00	
Pseudo R2		0.11			0.12			0.12			0.12			0.12			0.12	