Banks, specific risk and cost of equity: the Bank's Capital at Risk Model[1]

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Abstract

In this paper, we propose a model for estimating the cost of capital of banks that we dub Bank Capital at Risk Model (B-CaRM). Based on the theory of investors' under-diversification, the B-CaRM enables to estimate the banks' cost of equity by considering both the systematic and specific risk. Assuming the irrelevance of the financial structure of firms and adopting a totally levered approach, the B-CaRM extrapolates the cost of capital by adding to the risk-free, a risk premium over the portion of the assets' Value at Risk calculated by the loss given default perceived by debt-holders. We empirically tested the model studying the relationship between Value at Risk (broken down into systematic and specific Value at Risk) and the variables affecting systematic and specific risk of banks. We found that the model is able to price both the systematic and specific risk.

Keywords: Specific Risk, Default Risk, Value at Risk, Cost of Equity, Bank

JEL Classification: G12, G21, G32

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[1] Although the paper is the result of a joint effort, Section 2 and 5 are due to F. Beltrame, Section 1 and 4 are due to D. Previtali and Section 3 is due to L. Grassetti. The authors are in alphabetical order. In case of acceptance F. Beltrame and D. Previtali will be the presenters of the paper.

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1. Introduction

Valuing banks is one of the most difficult issue to address in corporate finance and the enduring turmoil which has been characterizing the aftermath of the financial crisis of 2007, have made it even more complicated (Damodaran 2013). All the recent academic contributions on the topic (among the others: Damodaran, 2013; Koller *et al*, 2012; Massari *et al*, 2014) have highlighted that valuation of financial institutions requires an equity-side approach and, consequently, an estimation of the cost of equity instead of weighted average cost of capital.

The interest among academics on the topic of capital structure and valuation of banks has been raising in the aftermath of the financial crisis of 2007. The strengthening of the capital base required by the regulatory Authorities (i.e. Basel III framework, EBA directives) to undercapitalized banks to absorb the potential losses that might have been arisen from "hidden" risks in the business, may affects the way banks are valued. In particular, scholars have tried to study whether the more capital needed might have been more expensive for managers and stockholders. They have showed contrasting results. On one hand, Baker and Wurgler (2013) observed that high capital ratios are positively related to the cost of capital. Their results over the U.S. equity market evidenced a low risk anomaly behavior: better capitalized banks reported higher returns in the stock market. Consequently, higher capital ratios (of the relatively low risky banks) might be significant in terms of expected returns. On the other hand, the literature questioned whether the irrelevance of the financial structure (Modigliani-Miller, 1958, MM hereafter) can be applied also to financial institutions. According to the authors, higher capital requirements of banks should not affect cost of capital. With regard to these issues, Admati *et al* (2010 and 2012) have explained that if Modigliani-Miller proposition holds true, higher level of capital should not be more expensive in terms of the overall cost of capital, since more equity and less debt should not change banks' cost of funding. However, in a recent contribution, Masera and Mazzoni (2013) have pointed out that the irrelevance of banks' financial structure, especially during period of high systemic risk, does not hold true since banks plays a role of liquidity provider in the economic system and regulatory constraint may affect the cost of capital.

According to the evidences we just reported, it can be claimed that there is not a single and strong agreement on the issue. On the whole, the applicability of Modigliani Miller's proposition to banks seems still to be an open point in the literature.

Scholars have also recently dealt with the topic of banks' cost of equity by analyzing its relation with other variables such as risk weights optimization (Beltratti and Paladino, 2013), or in relation to disclosure (Palea, 2012; Chen and Gao, 2010; Poshakwale and Courtis 2005) showing that banks' cost of equity represents a very relevant variable for banks' management and valuation.

However, notwithstanding the relevance of the topics briefly discussed so far, to the knowledge of the authors, not so many scientific contributions analyzed the methodologies adopted in banks' cost of equity estimation, that is the main topic this paper wants to deal with.

In relation to this field of studies, Zimmer and McCauley (1991) proxied banks' cost of equity using a backward-looking accounting measure which compares an inflation and accounting-distorsion-adjusted earnings to market capitalization. A forward-looking approach was instead adopted by Maccario *et al* (2002) who extrapolated the cost of equity by using an inflation-adjusted dividend discount model. Assuming that analysts' expectations are the best proxy of future earnings and that dividend payout and growth rate are constant, the model estimates the banks' cost of equity through the reciprocal of price-earnings ratio. While a forward-looking method is far more preferable than a backward-looking measure, however the sensitivity to the model's input represents a relevant shortcoming (Easton, 2009; Barnes and Lopez, 2006). Describing the metrics used by the Federal Reserve in Private Sector Adjustment Factor calculation, Green *et al* (2003) compared three different solutions for banks' cost equity estimation: a dividend discount model approach (i.e. Maccario *et al*, 2002), an accounting earnings approach (i.e. Zimmer and McCauley, 1991), and the traditional CAPM (Sharpe, 1964). Following the Fed's review started in 2004, Barnes and Lopez (2006) assessed that the CAPM was the most reliable method among them. A general analysis of the banks' cost of equity have been presented by King (2009) who, using a single factor inflation-adjusted cost of equity, studied its trend in six countries over the period 1990-2009 highlighting that, in the CAPM approach, hold many significant shortcomings such as the limitations of the mean-variance approach and the insufficiency of a single market factor to explain the cross-section realized returns.

Not specifically related to banks, some important contributions have tried to overcome the usage of the simple single-factor CAPM. Fama and French (1992, 2004) have underlined that most of the CAPM applications are unreliable owing to the imprecision in estimating the parameters of the model. Additionally, they proposed the three factors model (TRM) widening the systematic risk factors to be priced in the cost of capital and differentiating for size and price to book ratios. Also Ross (1976), with his widely known Arbitrage Pricing Theory (APT), introduced others macroeconomic factors which should be able to explain equity variations among stocks. The importance of those models are recognized and used also by practitioners (Bruner *et al*., 1998; Graham and Harvey, 2001). However, although the limits of the capital market equilibrium hypothesis, on the whole, the single or multi-factor CAPM and the APT model seem to be the methods most applied in financial institutions' cost of equity estimation (Damodaran, 2013).

All the cost of capital methods previously mentioned rest on the principle that cost of equity must reflect the portion of systematic risk that cannot be diversified away by the marginal investor. In fact, firm-specific risk should not be relevant for investors as they are supposed to fully diversify their portfolio in absence of transaction or liquidity constraints. As a result, the single component to be priced in the cost of capital should be the systematic risk. In this paper, we question such theoretical approach by affirming that an additional portion of idiosyncratic risk must be priced in the cost of equity of banks and that the marginal investor approach is by now a too restrictive assumption in relation to the total portfolio diversification theory. On the whole several market imperfections such as bankruptcy costs (Bris *et al*, 2006) and imperfect diversification of agents (Stulz 1984, Smith and Stulz 1985) make costly the idiosyncratic risk.

In this paper, we claim that banks' cost of equity should reflect the assets' riskiness and composition since the variability of the cash flows not only depends on systematic risk, but on the idiosyncratic one as well. As a matter of fact, high volatility of earnings entails a high degree of firm-specific risk which, under specific circumstances, expose investors to insolvency or bankruptcy costs. Although this is widely acknowledged by the literature, as previously underlined, the most broadly accepted approaches in the estimation of cost of capital do not take into account the idiosyncratic component of risk since the underpinning theoretical framework assumes a total portfolio diversification of the marginal investor. However this is true only if investors hold a real completely diversified portfolio, but, effectively, they do not (see among the others Barber and Odean, 2000; Benartzi and Thaler, 2001). As a matter of fact, investors are inclined to have a limited number of assets in their portfolios so that they cannot be fully diversified. Goetzmann and Kumar (2008), using a sample of more than 60 thousands investors, found that more than 28% hold just one stock, 60% hold not more than three stocks and 9% of investors hold more than 10 stocks. In these terms, according to Kearney and Potì (2008), the number of stocks required to reduce the idiosyncratic volatility to 5% in a portfolio of European stocks was of 166 in 2003. Moreover, owing to the specifics of the banking business, holding banks' stocks can raise the level of idiosyncratic risk in investors' portfolios and, therefore, requiring an additional number of assets to reach a totally diversified portfolio (Yang J., Tsatsaronis, 2012). The factors affecting the lack of diversification in investors' portfolios can be either endogenous (Hirshleifer, 2001), such as the lower efficiency in composition and sizing of portfolios; and exogenous factors, for instance the institutional restrictions (i.e. limitations in short-selling or liquidity restrictions) that may force investors in holding an under-diversified portfolio (Merton, 1987). As a result, the under-diversification issue should lead investors to care about not only of systematic risk, but of idiosyncratic one as well, thus, requiring higher compensation for holding additional portions of idiosyncratic risk (Fu, 2009; Malkiel and Xu, 2002).

The under-diversification becomes even more evident in case of the strategic investor when the owner, or the relevant and influencing stockholder in a private or publicly traded company, has a big share of its net worth invested in the business. These concentrated investments expose to a high degree of idiosyncratic risk, requiring higher returns for the hold equity stake which, in turn, implies a higher cost of equity capital (Mueller, 2008).

In this paper, we propose a model for banks' cost of equity estimation, the B-CaRM, which basing on the contribution of Beltrame *et al* (2014), provides a measure of the adequate expected return considering both the systematic and idiosyncratic risk of a bank. More specifically, the B-CaRM prices the expected returns by estimating the default risk of a bank using the theoretical approach of Value at Risk and combining the information of individual stock price with other core variables typically obtainable from banks' balance sheets.

We contribute to the literature by providing a measure of banks' expected returns for those investors who might not be holding a fully diversified portfolio, especially, in the case of the strategic investor (i.e. merger and acquisitions). A bank-specific cost of equity can lead strategic investors and managers in undertaking remunerable business decisions, while for investors, an adequate estimate of a bank cost of equity can drive for efficient portfolio allocation. Finally, for policymakers, assessing a sound and adequate measure of bank cost of capital, may better inform on the incentives of managers and investors in undertaking risky investments.

The next section explains the B-CaRM model. Section 3 discusses the data and empirical approach. Section 4 provides the empirical results in addition to robustness checks. Section 5 concludes.

2. The B-CaRM Model

2.1 Model's theoretical framework

The deterioration of the creditworthiness of many companies involves the perception of an increased default risk for shareholders. In fact, assuming the relevance of idiosyncratic risk, the quantification of shareholders' default risk premium can be useful in the determination of the cost of equity both for non-financial and financial firms.

In these terms, several studies have shown a lack of positive correlation between default risk and equity returns (Dichev, 1998; Garlappi *et al*, 2008; Avramov *et al,* 2009, George and Hwang, 2010; Garlappi *et al*, 2011), although, for financial distressed firms, variables like volatility and market beta have proved to be highly correlated with default risk (Campbell *et al*, 2007). In other studies, using different dependent variables instead of stock market prices, the results seem to be contrasting. As a matter of fact, Chava and Purnanandam (2010), using the implied cost of capital derived by analysts' assessments, found that the cost of capital is positively related to default risk, and Vassolou and Xing (2004), employing a structural model to quantify default risk, highlighted that firms with higher default risk reported higher returns. In addition, using bond ratings as a measure of the deterioration of economic and financial conditions of companies, several studies found that a bond downgrade is usually followed by a negative stock return (Holthausen and Leftwich, 1986; Hand *et al*, 1992; Dichev and Piotroski, 2001) highlighting a strong relation between default risk perception and expected equity returns.

These evidences show that the cost of debt and the cost of equity, whether obtained with alternative measures than equity returns, exhibit some similarities because both configurations of cost include a firm's default risk estimation. In other words, default risk affects not only third party lenders in the normal lending activity, but also shareholders in a similar way like subordinated debtors (Oricchio, 2012).

According to such perspective, in this paper, we propose the application of *Capital at Risk Model* (Beltrame *et al*, 2014) to the banking industry relying on Value at Risk approach and Modigliani and Miller's proposition (1958). This is because we believe that a cost of equity estimation which exploits the concept of Value at Risk as a measure of unexpected loss can adapt more effectively to companies that already employ Value at Risk methodology for minimum capital requirements quantification.

First of all, it is essential to determine whether the MM irrelevance proposition[3] is also applicable to banks. In these terms, one of the main reasons the literature has considered for the hypothetical inapplicability of MM's proposition is the presence of Basel's capital constraints. As a matter of fact, high and specific regulatory requirements may indirectly alter the risk-return profile of banks' assets affecting their cost and the overall firm value (Masera and Mazzoni 2013).

The second issue would be related to the role of banks as liquidity providers which they play by holding deposits and making lending activity. Focusing on the deposit side, through this specific form of financing, the benefits for banks are two-fold: firstly an increase of the volume of credit intermediation due to the deposit multiplier, and, secondly, the lower cost of deposits, compared to the one of other forms of funding, reduces the overall cost of capital. Such effects have a relevant impact on the value of a bank, since a substitution of deposits with equity capital implies both a lower capacity to generate additional volumes of intermediation and a lower level of returns. The

[3] According to MM proposition, under market efficiency, absence of asymmetric information, absence of taxation and absence of distress costs, the capital structure has no impact on firm value.

impact of an increased use of deposits in place of equity can be explained also in terms of the related guarantees of deposits. With regard to the guarantee, Masera and Mazzoni (2013) claim that the presence of government guarantees (or equivalent technical forms) would directly affect value creation, thus violating the irrelevance of MM proposition supporting the literature that shows that a replacement of equity with deposits reduces the cost of capital.

The empirical evidence on the relationship between banks' capital structure and value are heterogeneous. While Mehran and Thakor (2011) establish the significance of the capital structure on bank's firm value, conversely, Kashyap (2010) explains that for higher levels of leverage, the cost of equity compensates the more favorable effect of the cost of debt on the weighted average cost of capital. In addition, there is evidence that banks, whose capital is well above the regulatory minimum requirement, manage the leverage in a similar manner of non-financial companies (Reint and Florian, 2009). In addition, the increase in value due to the liquidity generated by a greater use of deposits (in place of equity) is not a mere substitution among sources of funding, but an increase of capital raised, in contrast with MM proposition. In support of this thesis, Adamati *et al* (2010) state that: "*The assumptions underlying the Modigliani-Miller analysis are in fact the very same assumptions underlying the quantitative models that banks use to manage their risks, in particular, the risks in their trading books. Anyone who questions the empirical validity and relevance of an analysis that is based on these assumptions is implicitly questioning the reliability of these quantitative models and their adequacy for the uses to which they are put – including that of determining required capital under the model-based approach for market risks*".

On the whole, notwithstanding the arguments of MM's inapplicability over banks are examples of typical constraints, frictions and opportunities, we point out that if we strictly interpret the MM's first proposition in absence of taxes, where there is no frictions and constraints, MM's proposition would not be applicable neither for industrial companies nor for banks (Miller, 1995). In other words, there are not strong reasons to rule out the MM' proposition only for banking firms.

Thus, in this paper, we assume the MM irrelevance in order to formulate the Bank Capital at Risk Model (B-CaRM), so that in the absence of constraints and frictions, the cost of capital is described by [1] where r_0 is the weighted average cost of capital in absence of taxes, r_E is the cost of equity, r_D is the cost of debt, *E* is the market value of equity, *D* is the market value of debt and *V* is the firm's total value.

$$\mathrm{r_0} = \mathrm{r_E}\frac{\mathrm{E}}{\mathrm{V}} + \mathrm{r_D}\frac{\mathrm{D}}{\mathrm{V}}$$

[1]

On the basis of [1], we can claim that for higher levels of leverage, the cost of debt grows at a fixed weighted average cost of capital. Considering the case of a totally levered bank (Merton 1974) where creditors hold the risk of the business, it is possible to state in [2], that the required return on unlevered firm is equal to required return on a totally levered firm.

$$V = D \rightarrow r_0 = r_{D,TL}$$

[2]

In the B-CaRM, we will assume a totally levered framework.

2.2 The CaRM's cost of capital

The evaluation scheme of the CaRM model states that the value of the company is divided into two components: the 'certain' value (V^{low}), according to a determinate confidence interval, and the 'uncertain' value as a function of the unexpected loss (CaR_V), obtainable by calculating the value at risk on the distribution of asset values.

$$V = V^{low} + CaR_V$$

[3]

Such approach to valuation stems from the expected and unexpected losses remuneration mechanism which is theoretically (and practically) consistent with regulation and pricing policies adopted by banks.

According to CaRM, only unexpected losses have to be priced in risk premiums, while expected losses should not be taken into account in the pricing process. This is because, in the risk neutral theoretical framework, for a borrower requiring a risk-neutral rate, it would be indifferent to obtain the risk-free rate or the correspondent rate applied assuming no default or total capital recovering (assuming the hypothesis of default). This relation can be written by equation [4] where: r_f is risk-free rate; PD is the probability default of the borrower; r_{RN} is risk neutral rate; RR is the recovery rate.

$$1 + r_f = (1 - PD)(1 + r_{RN}) + PD \cdot RR(1 + r_{RN})$$

[4]

The risk-neutral rate would be a purely nominal remuneration while, on the contrary, the risk-free rate represents the true required return by debtholders or shareholders, in the absence of unexpected losses. On the contrary, in case of unexpected losses, the cost of capital should include a risk premium to compensate the losses arising from the lower cash flows of reimbursement.

In such perspective, the Value at Risk approach can be considered a useful and consistent measure of unexpected losses allowing us to determine the related risk premium over the idiosyncratic risk of a bank[4]. Therefore, the sum of the risk free and risk premium will respectively represent the remuneration of expected and unexpected losses for both shareholders of an unlevered firm and debtholders of a totally levered firm.

Having assumed that the bank is totally levered, the totally levered third-party lenders will require a risk-free rate on the portion of 'certain' capital, while they will expect a higher rate and equal to the risk-neutral rate (r_{RN}) on the capital at risk (CaR). It is now possible to determine the shareholders' required rate of return of the unlevered (and totally levered) firm by the weighted average of the risk-free rate and risk neutral rate as:

$$r_0 = r_{D,TL} = r_f \frac{V^{low}}{V} + r_{RN} \frac{CaR_V}{V} = r_f V_{\%}^{low} + r_{RN} CaR_{V,\%}$$

[5]

so that:

$$\mathrm{r_0 = r_f + CaR_{V,\%}(r_{RN} - r_f)}$$

[6]

where the difference between the risk neutral rate and risk free rate is defined as the default premium, while the $CaR_{V,\%}$ is the fraction of capital at risk that depends on the specific and systematic risk.

2.3 Risk neutral rate for bank's shareholders

Considering the totally levered approach used in B-CaRM, the most appropriate remuneration for third-party lenders is represented by the risk-neutral rate since the capital at risk is

[4] According to a parametric approach and normal distribution of assets, the Value at Risk can be obtained as a multiple of assets' standard deviation. In particular, using a structural model and market data (market capitalization, equity standard deviation and face value of debt), we can obtain the value at risk by the value of total asset and its standard deviation.

subject to unexpected losses. A firm in which the value of debt exactly corresponds to the value of assets is substantially in the hands of the debtholders and it is in a state of economic default (Merton, 1974). Therefore, the risk neutral rate will be exclusively a function of the loss given default perceived by third-party lenders where *LGDR* is the loss given default rate.

$$r_{RN} = f(LGDR) = \frac{r_f + LGDR}{1 - LGDR}$$

[7]

The equality between the rate applied by the risk-neutral third-party lenders and the one ideally applied by the shareholders of unlevered firm is verified when the potential losses for third-party lenders in case of default, corresponds to one received by shareholders in case of business interruption. This is because, in case of default, lenders will recover as loaned by the sale of firm's assets as it occurs for shareholders in case of liquidation. On the contrary, in case of no debt, losses occurs due to the decline in cash flows since the firm is still able to run the business.

In one period, cash flows drop down when we have impairment, depreciations and repayments of assets. The value falls proportionally to the lower level of invested capital. Assuming a simplified asset value model:

$$V = \frac{ROA_{Assets} \cdot Total\ Assets}{r_0}$$

[8]

where ROA_{assets} is the return on the asset of a bank without interests expenses; *Total Assets* are the amount of capital invested; r_0 is the discount rate for unlevered firm.

A variation of assets will produce a proportional change in the firm value:

$$\frac{\partial V}{\partial Total\ Assets} = k$$

[9]

More technically a variation in value is a function of a variation of total asset which is a function of the loss rate (LR) that is calculated as in [10].

$$LR = \frac{Depreciations + Impairments + Asset\ repayments}{Total\ Assets}$$

[10]

In particular, compared to the original Capital at Risk model (Beltrame *et al*, 2014), for financial intermediaries, the calculation of the loss rate is affected by assets repayments. This is due to the fact that the deviation of the negative cash flows of a bank can be given by a lower investment in earning assets resulting in a decrease in interests and fees.

2.4 A structural model for the Capital at Risk

A practical solution to obtain value at risk coefficient is to use Merton's structural model (1974) as it is possible to extend the model to typical bank's liabilities such as deposits (Merton, 1977).

The model proposed assumes that the value of firm's assets (V) follows a stochastic process of the type geometric brownian motion with parameters μ_V (average) and σ_V (volatility of the process):

$$dV = \mu_V V dt + \sigma_V V dn$$

[11]

Taking advantage of the Ito's Lemma, we get the differential of each function. In particular, in case of the Merton model (1974) equity can be interpreted as a European call option on the value of the firm, with a strike price equal to the face value of the debt and equivalent time to maturity.

Given Equity (E), the volatility of the equity (σ_E), the nominal value of the debt (*D*), the risk free rate (*r*) and time (*T*), in the case of Merton, we can express the Black and Scholes (1973) formula as:

$$E = V\,N(d_1) - De^{-rT}N(d_2)$$

[12]

where:

$$d_1 = \frac{ln\left(\frac{V}{D}\right) + \left(r + \frac{\sigma_V^2}{2}\right)T}{\sigma_V\sqrt{T}}$$

[13]

$$d_2 = d_1 - \sigma_V \sqrt{T}$$

[14]

$$\sigma_E = \sigma_V \frac{V}{E} N(d_1)$$

[15]

N is the normal distribution, *d1* and *d2* are the same parameters of Black and Scholes formula. Reversing the [12] and [15] we can get a measure of firm value (V) and implicit asset volatility.

The structural model implicitly assumes that, in the absence of arbitrage between assets' value and free risk investments, asset value at time *T*, follows a lognormal distribution and the logarithm of *Vt* is distributed as a normal distribution characterized as follows:

$$V_T \to LN\left[\left(r_f - \frac{\sigma_V^2}{2}\right)T + ln(V_0), \sigma_V \sqrt{T}\right]$$

[16]

The certain value with an *alfa* interval confidence will be:

$$V_{\alpha,0}^{low} = \phi^{-1}(\alpha) = \exp\left(\mu + \sigma N^{-1}(\alpha)\right)$$

[17]

and the Capital at risk (%) is:

$$CaR_{V,\%} = \frac{V - V_{\alpha,0}^{low}}{V} = \frac{CaR_V}{V}$$

[18]

Taking advantage of the Merton model and the properties of logarithms, we can reach the probability of default and, consequently, the risk-neutral rate that can be represented as:

$$r_{RN} = r_f - \frac{1}{T} ln\left[N(h_1)\frac{1}{d} + N(h_2)\right]$$

[19]

where $N(h_2)$ is *1-PD*, while $N(h_1)\frac{1}{d}$ is the recovery rate (RR) multiplied by the probability of default (PD). If the value of debt tends to the value of assets, the probability of default would increase to 100% since:

$$N(h_1) \to 1; N(h_2) \to 0$$

[20]

so that the recovery rate is 1/d. Finally, using a one year time horizon, we can estimate r_{RN} as:

$$r_{RN} = r_f - ln(1 - LGD)$$

[21]

where the risk-neutral rate applied by third-party lenders depends solely on the loss given default.

Finally, through the risk neutral rate, it is possible to calculate the expected loss rate and formalize the model using the exponential capitalization:

$$r_0 = r_f + ln\left(1 + \frac{ELR_{TL} \cdot CaR_{V,\%,}}{1 - ELR_{TL}}\right)$$

[22]

where ELR_{TL} is the Expected loss rate using a totally levered approach.

2.5 The bank's cost of equity and cost of debt in the CaRM

How it is widely accepted by literature, valuation of financial institutions requires an equity-side approach and, consequently, an estimation of a cost of equity instead of weighted average cost of capital.

The B-CaRM claims that the cost of equity capital is determined by the application of MM theorem in presence of taxes (Modigliani and Miller, 1963), where the capital at risk for debtors is a function of the assets minimum value. The B-CaRM states that the bank's cost of equity can be determined by:

$$r_E = r_f + CaR_{V,\%}(r_N - r_f) + \left[CaR_{V,\%}(r_{NR} - r_f) - CaR_{D,\%}(r_{RN,D} - r_f)\right]\frac{D}{E}(1 - T_c)$$

[23]

The model allows to appreciate the impact of the fraction of risky assets and leverage on the cost of capital enabling to take into account of unexpected losses for systematic and specific risk with a small set of variables.
Consistently, the model is applied to the pricing of debt capital, first quantifying Capital at Risk (%) for debtors:

$$CaR_{D,\%} = max\left[0; \frac{D_0 - V_\alpha^{low}}{D_0}\right]$$

[24]

and then the cost of debt:

$$r_D = r_f + CaR_{D,\%}\left(r_{RN} - r_f\right)$$

[25]

Using exponential capitalization we have:

$$r_D = r_f + ln\left(1 + \frac{ELR \cdot CaR_{D,\%,}}{1 - ELR}\right)$$

[26]

where the expected loss rate is a function of the probability of default and loss given default rate. In this way, it is easy to understand how the model can be a viable solution not only to quantify the cost of equity, but also for loan pricing since the approach we are assuming is the required return for debtholders.

3. Methodology and Sample

3.1 Descriptive analysis

We tested the B-CaRM on a sample of 141 European listed banks with data spanning over 2009 to 2013. We gathered consolidated data from Bankscope BvD. The observed panel is incomplete. In particular, looking at the response variable (CaR), 102 observations are missing across the five years considered. In particular, the conditional time distribution of the observed

“CaR” measures is as in Table 1. As one can notice the missing observations are mainly concentrated in years 2009 and 2013.

Table 1 The empirical distribution of observations in years

Year	Absolute frequency	Missing values percentage (%)
2009	117	17.02
2010	122	13.47
2011	123	12.77
2012	127	9.93
2013	114	19.15

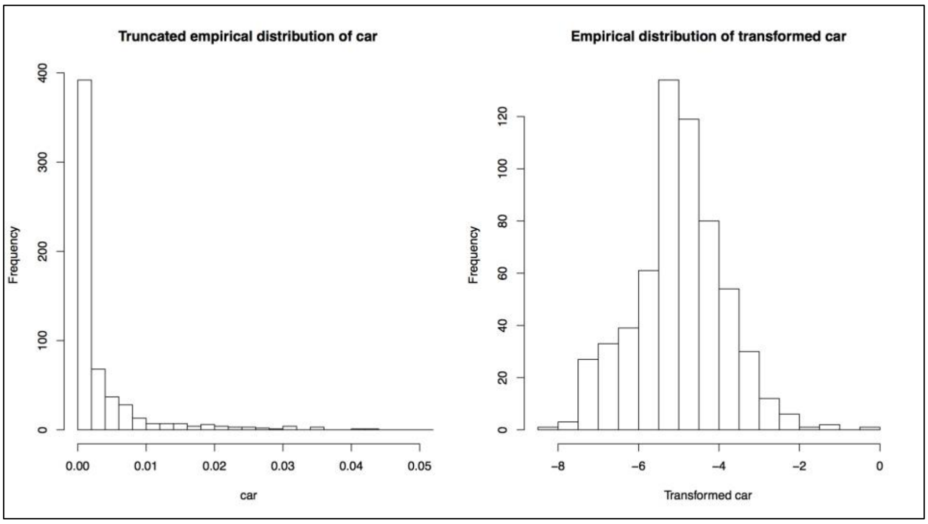
The type of bank considered are: “bank holding & holding companies”, “commercial banks”, “cooperative banks”, “savings banks” as reported in Table 2. As one can notice, the sample is composed, for the most part, by commercial banks (68% of observations).

Table 2 Bank type distribution

Bank type	Absolute frequency	Relative frequency (%)
Bank Holding & Holding Companies	15	10.64
Commercial Banks	96	68.08
Cooperative Banks	24	17.02
Saving Banks	6	4.25
Total	141	100.00

Looking at the empirical distribution of the CaR measures (Figure 1), the empirical density distribution of VaR (considering the limitation to the closed interval [0 ; 0.05] - some observations are omitted) shows a clear skewness. A possible solution to this issue is to consider the Box-Cox transformation of the original data which distribution is represented in Figure 1 as well.

Figure 1 Distribution of original CaR measures and their Box-Cox transformation



The empirical analysis shows that the optimal data transformation coefficient is equal to 0.101. All the following analyses are developed considering the Box-Cox transformation.

CaR is obtained through the Merton Model using the following input variables for each year:

- Bund10 year (average) like risk-free rate;
- Market capitalization;
- Yearly standard deviation of equity measured by a transformation of daily standard deviation (time period: one year);
- Total debt of the bank (funding).

CaR values extracted by the sample and market data are studied as a function of some systematic and idiosyncratic banks' variables which represent the most part of banks' value drivers. To do this, we use a market model to split the variance between systematic and specific risk:

$$r_t = \beta r_m + \epsilon$$

[27]

From [27], we can write:

$$\sigma_{r_t}^2 = \beta^2 \sigma_{r_m}^2 + \sigma_\epsilon^2$$

[28]

Replacing [15] in [28], we have:

$$\sigma_V^2 \left(\frac{V}{E}\right)^2 N^2(d_1) = \beta^2 \sigma_{r_m}^2 + \sigma_\epsilon^2$$

[29]

Therefore, we can exploit asset variance (Choi and Richardson, 2008):

$$\sigma_V^2 = \frac{E^2}{V^2 N^2(d_1)} \beta^2 \sigma_{r_m}^2 + \frac{E^2}{V^2 N^2(d_1)} \sigma_\epsilon^2$$

[30]

The term $E/[VN(d_1)]$ is the mutual market leverage that depends from the probability of default. Thus, $\frac{E^2}{V^2 N^2(d_1)} \beta^2 \sigma_{r_m}^2$ is the systemic variance, while $\frac{E^2}{V^2 N^2(d_1)} \sigma_\epsilon^2$ is the specific one.

The CaR is a multiple *K* of standard deviation:

$$CaR_{V,\%} = \frac{k\sigma_V}{V}$$

[31]

Multiplying the terms for k^2/V^2 we can separate the two components of CaR:

$$CaR_{V,\%}^2 = \frac{k^2}{V^2}\frac{E^2}{V^2N^2(d_1)}\beta^2\sigma_{r_m}^2 + \frac{k^2}{V^2}\frac{E^2}{V^2N^2(d_1)}\sigma_\epsilon^2$$

[32]

In [33] we reported the squared idiosyncratic component of CaR:

$$CaR_{V,\%,Id.}^2 = \frac{k^2}{V^2}\frac{E^2}{V^2N^2(d_1)}\sigma_\epsilon^2$$

[33]

while in [34] the systematic one:

$$CaR_{V,\%,Sy.}^2 = \frac{k^2}{V^2}\frac{E^2}{V^2N^2(d_1)}\beta^2\sigma_{r_m}^2$$

[34]

The used explanatory variables are reported in Table 3.

Table 3 Explanatory variables used in the following CaR analyses

Independent variables	Type of risk	Variable*
CAPM beta	Systematic	CaRsy
Year	Systematic	D
Size	Idiosyncratic	ln totass
Asset growth	Idiosyncratic	dtotass
Asset density	Idiosyncratic	drwa
Non Performing Loans	Idiosyncratic	dnpl
Capital adequacy	Idiosyncratic	dtier
Profitability	Idiosyncratic	roaa
Operating leverage	Idiosyncratic	overta
Credit risk	Idiosyncratic	llpgl

* the variables which are preceded by “d” represent first differences values x(t) – x(t-1).

Idiosyncratic variables are considered in the first difference form in order to transform a stock measure into a flow. On the contrary, the variables obtained from profit and loss account are considered in the year when the CaR is calculated. Given their characterization, these measures could have been naturally correlated. Thus, we run the VIF test of which results are reported in Table 4.

Table 4 VIF values

Variable	VIF	Standardized VIF
lntotass	1.9855	1.4091
dtotass	3.0590	1.7490
drwa	3.1040	1.0392
dnpl	1.0799	1.0976
dtier	1.2047	1.0976
roaa	2.7639	1.6625
overta	1.9800	1.4071
llpgl	16.5672	4.0703
llpta	19.4220	4.4070

As we can notice the only two variables showing problematic VIF values are *llpgl* and *llpta*. The following analyses will be developed considering credit risk (*llpg*) variable only. As a matter of facts, the absolute values of all the correlations are lower than 0,7 and the most of them are close to 0.

A preliminary analysis of relationship between value at risk and time and specialization is developed in Table 5. It summarizes the conditional means and standard deviations of CaRs. Results suggest a possible relationship between bank specialization and value at risk measure. In particular the cooperative banks present the lowest VaR measures.

Table 5 The conditional summary statistics for CaR transformed measures

Variable	Mean	Standard deviation
Global	-4.9768	1.1192
Bank Holding & Holding Companies	-4.8488	0.9473
Commerchial Banks	-4.7547	1.0297
Cooperative Banks	-6.0759	0.8703
Saving Banks	-5.2867	1.4992
Year 2009	-4.5672	1.1760
Year 2010	-5.0587	1.0051
Year 2011	-5.1991	1.0464
Year 2012	-5.1878	1.0010
Year 2013	-4.8344	1.2518

The two panel dimensions are also studied by a graphical representation of their time and individual heteroskedasticity.

Figure 2 Time trend and heteroskedasticity

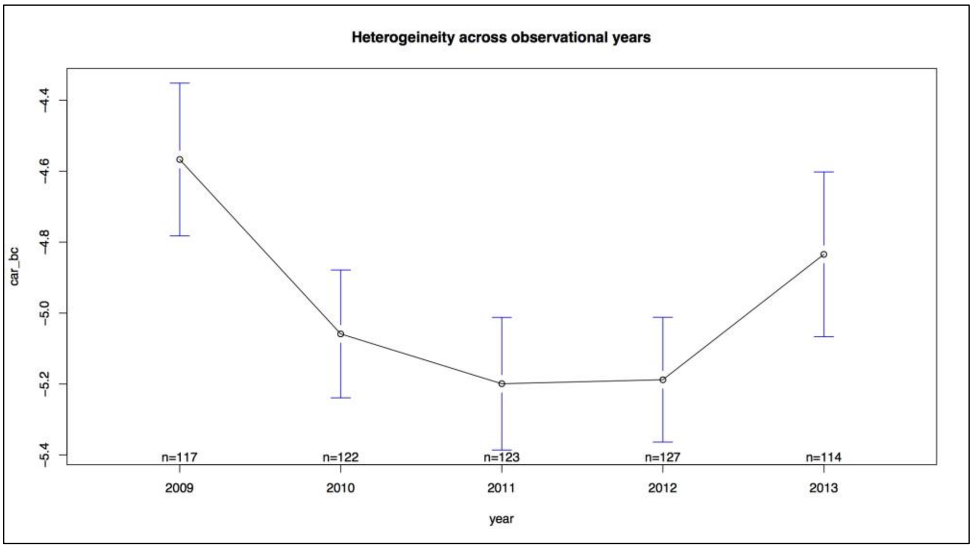
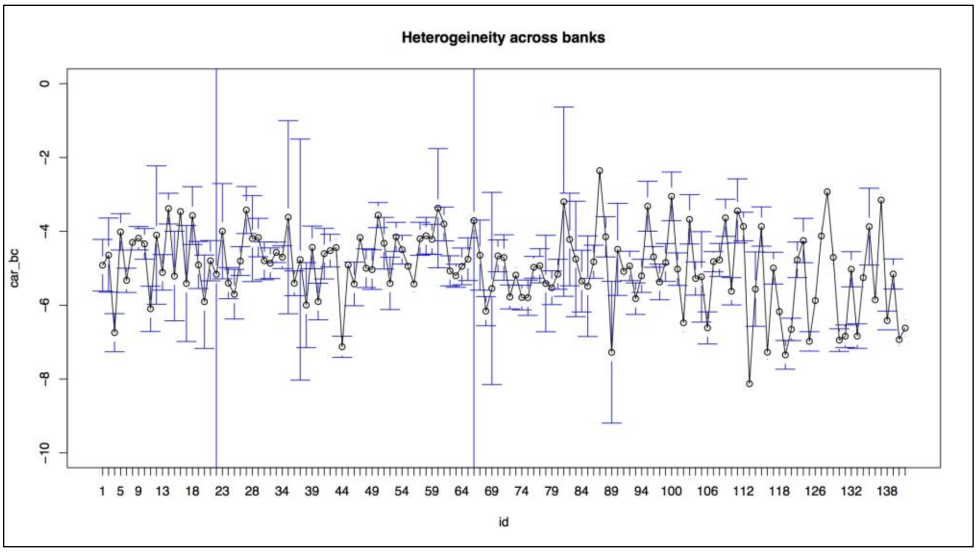


Figure 3 Individual effect evaluation



Specific linear time trend and time heteroskedasticity is not significant. Individual bank effects are quite different and their variability is also heterogeneous.

3.2 The model specification and estimation results

We decided to test the relation between CaRs and banks' esplicative variables running two regressions: the first (*Model 1*), testing the relation between Idiosyncratic CaR ($TCaRid_{i,t}$) and banks' financial statement variables; the second (*Model 2*), testing the relation between the Total CaR (the sum of Systematic and Idiosyncratic CaR, $TCaR_{i,t}$) and banks' significant variables of *Model1*, with the addition of the 5 year regression beta ($CaRsy_{i,t}$) as a measure of systematic risk.

In order to derive the best specification of the model, we tested for some important assumptions. First of all, we analyzed the individual heteroskedasticity by considering a dummy variable regression (DV regression) in which the individual effects enter the classical linear model. The models comparison highlight two peculiar results. The goodness of fit of the DV regression is quite larger than the linear model. The esplicative variables in the two model specifications present different significance. The same result can be obtained by comparing the ordinary linear model with the within estimation of panel data fixed effect model. The result of this comparison suggests that the fixed effect model is a better choice. In order to test the so called poolability, we considered the testing procedure based on the evaluation of the pooled model. The LM test (Breusch-Pagan) result shows that individual effects are needed (p-value < 0.0001).

Moreover, we tested for time effect. The comparison of fixed or random effect models estimated with or without the time dummies can guide our final choice. Under both the individual effects specification, the model comparison is favorable to the introduction of time effects. Also in this case the LM multiplier can be adopted to test for time effects significance. Under both fixed and random effects hypotheses the testing procedure identifies significant time effects.

In order to choose between the random and fixed effect model specification, we run a Hausman test. The results of the testing procedure (p-value = >0.001) are in favor of the random effects model specification.

Finally, *Model 1*can be defined as:

$$\mathrm{TCaRid}_{i,t} = \alpha_i + \sum \beta_t D_t + \gamma_1 \ln \mathrm{totass}_{it} + \gamma_2 \mathrm{dtotass}_{it} + \gamma_3 \mathrm{drwa}_{it} + \gamma_4 \mathrm{dnpl}_{it} + \gamma_5 \mathrm{dtier}_{it} + \\ + \gamma_6 \mathrm{roaa}_{it} + \gamma_7 \mathrm{overta}_{it} + \gamma_8 \mathrm{llpgl}_{it} + \varepsilon_{it}$$

where: $\alpha_i = \alpha + u_i$ is the sum of intercept and a random individual (bank) effect, *roaa* is measured by net income divided total average assets, *overta* is measured by operating costs divided total assets, *llpgl* is measured by loan loss provisions divided gross loans.

Thus, *Model 2* cab be written as:

$$\mathrm{TCaR}_{i,t} = \alpha_i + \gamma_0 \mathrm{CaRsy}_{it} + \sum \beta_t D_t + f(\mathrm{sel\ var}) + \varepsilon_{it}$$

where f(sel var) is the linear deterministic model selected in *model 1*.

In order to test the model specification we also proceed with the Breusch-Godfrey/Wooldridge test for serial correlation in panel models . The testing procedure suggests that residual serial correlation is present in the idiosyncratic errors (p-value 0.0333). The model estimation can be affected by stationarity issues. The results of a Covariate Augmented Dickey-Fuller (CADF – Hansen, 1995b) test suggest that the transformed data CaR presents a unit root while once the model is considered the residuals do not present any stationarity issue (p-value near to 1). Another possible issue is represented by the presence of residual heteroskedasticity. In this case the studentised Breusch-Pagan test presents a p-value lower than 0.001 in favour of the alternative of presence of heteroskedasticity. The efficiency of model estimators is then cursed by heteroskedasticity for this reason we considered the White correction of coefficient covariance matrix. Moreover, the power transformation we adopted significantly reduces the effect of heteroskedasticity. The sandwich error estimator can be applied to the obtained estimated models. In Table 6 and Table 7 the third column of both estimated models report the corrected p-values.

4. Results

In Table 6 and Table 7, we reported, respectively, the results of Model 1 and Model 2 regressions considering the lagged *t-1* version of the model[5]. Thus, the estimation is made on the observed CaRs in year *t* in relation to the explanatory variable measured in *t-1*.

With regard to the specific risk (Table 6) risk weighted asset density, capitalization, efficiency ratio and credit risk show a positive significant relation with Idiosyncratic CaRs.

As expected, the RWA density variable has a strong significant relation with Idiosyncratic CaRs. In facts it represents a forward-looking information of future outstanding risk in banks' portfolios and, consequently, it directly leads to an increase of the amount of CaR. Thus, the higher the level of risk in banks' asset influences the expected idiosyncratic volatility since RWA density can be interpreted as a forward looking measure of banks' riskiness.

The increase of overheads to total asset may contribute to a specific CaR increase due to the effect of the operating leverage over risk. As a matter of facts, *ceteris paribus*, a reduction of operating income, that is more likely to occur during periods of financial turmoil, has a direct effect on expected earnings and on the obtainable potential dividends. As a result, stock market price volatility can be strongly affected by the operating leverage and by the degree of efficiency banks are determined to reach.

[5] The following explanatory variables are considered in *t-1*: *lntotass*, *roaa*, *overta*, *llpgl*. The other independent variables are taken as a variation from *t-1* to *t*: *dtotass*, *drwa*, *dnpl*, *dtier*. The *carsy_bc* variable is a 5 year regression beta calculated on the S&P 500 Index.

Among the significant variable, the positive relation between Idiosyncratic CaRs (as a measure of specific risk) and capitalization is explained by the specific role of capital in banks' balance sheet.

Table 6 Lagged model - Idiosyncratic CaR

Dep. Variable: Idiosy. CaR	Model 1			Model 1 Selected Variables		
Variable	Estimated value	Std. Error	Corrected p-value	Estimated value	Std. Error	Corrected p-value
(Intercept)	-6.7771	1.1780	0.00000	-6.1491	0.2187	0.0000
lntotass	0.0266	0.0562	0.67990			
dtotass	-0.0069	0.0049	0.32650			
drwa	0.0121	0.0042	0.02160	0.0080	0.0024	0.0001
dnpl	0.0000	0.0002	0.57220			
dtier	0.0077	0.0011	0.00000	0.0069	0.001	0.0000
lag(roaa)	-0.0303	0.0481	0.51460			
lag(overtota)	0.4780	0.1248	0.00480	0.3690	0.0858	0.0003
lag(llpgl)	0.1378	0.0532	0.07290	0.0852	0.0315	0.1943
factor(year)2010	-0.7161	0.1201	0.00000	-0.6667	0.1053	0.0000
factor(year)2011	-0.7831	0.1188	0.00000	-0.8019	0.1046	0.0000
factor(year)2012	-0.7438	0.1218	0.00000	-0.7230	0.1062	0.0000
factor(year)2013	-0.2539	0.1254	0.07010	-0.2133	0.1111	0.0971
Idiosyncratic error	0.4221			0.4262		
Individual error	0.6994			0.9100		
R^2	0.4554			0.3922		
Adj R^2	0.4398			0.3843		

Table 7 Lagged model - Total CaR

Dep. Variable: Total CaR	Model 2			Model 2 Selected Variables		
Variable	Estimated value	Std. Error	Corrected p-value	Estimated value	Std. Error	Corrected p-value
(Intercept)	-1.7678	0.7092	0.0774	-4.7370	0.1322	0.0000
carsy_bc	0.0281	0.0017	0.0000	0.0186	0.0014	0.0000
lntotass	-0.1396	0.0330	0.0011			
dtotass	-0.0035	0.0030	0.3404			
drwa	0.0060	0.0026	0.0298	0.0040	0.0017	0.0010
dnpl	0.0001	0.0001	0.5038			
dtier	0.0048	0.0007	0.0000	0.0048	0.0007	0.0000
lag(roaa)	-0.0949	0.0295	0.0006			
lag(overtota)	0.2192	0.0717	0.0279	0.3046	0.0504	0.0000
lag(llpgl)	0.0726	0.0323	0.1865	0.0999	0.0211	0.0250
factor(year)2010	-0.4369	0.0741	0.0000	-0.4410	0.0729	0.0000
factor(year)2011	-0.3465	0.0746	0.0000	-0.4607	0.0733	0.0000
factor(year)2012	-0.3278	0.0773	0.0000	-0.3816	0.0753	0.0000
factor(year)2013	-0.0510	0.0781	0.5990	-0.0937	0.0770	0.3697
Idiosyncratic error	0.1572			0.2089		
Individual error	0.1885			0.2452		
R^2	0.7024			0.5779		
Adj R^2	0.6762			0.5648		

Moreover, the regulatory capital has a role of debtholders losses protection and, on average, it is kept close to the minimum requirements or aligned with those of the competitors. As a consequence, the higher level of capital are costly for shareholders and cab be interpreted as an increasing of strategy of future risk-taking and, therefore, of its earnings volatility (Calem and Rob, 1999).

With regards to credit risk, the variation of NPLs seem to have a positive relation with Idiosyncratic CaRs but statistically not significant. On the opposite, the amount of loan loss provisions in relation to gross loans shows a strong positive explanatory power over Idiosyncratic CaRs. As expected, the higher the provisions, the higher the expected earnings and dividends contraction and, in general, a negative information of banks' assets riskiness which increase stock market volatility.

Finally, it has to be underlined that the lagged ROaA is not significant since, as expected, past operative performance has a very poor predictive power over future profitability, especially during period of financial turbulence. However the negative sign can be interpreted as a lowering of risk in terms of idiosyncratic volatility.

Looking at Table 7, the Total CaR panel regression, results show that the additional systematic risk variable (*carsy_bc*) is strongly significant at 99% level of confidence. The beta, as a measure of systematic volatility, has found positively related to Total CaRs as a multiplier of asset volatility. Such evidence demonstrates that the systematic risk (that we proxied with correlation of banks' stock market returns with S&P 500 that we assumed as the market portfolio) is a considerable factor in pricing risk premium and positively affects the Capital at Risk. However not only the systematic factor is found to be significant in explaining CaR's variance. As a matter of facts, all the other variables included in the Idiosyncratic CaR regression remained statistically significant and with the same sign. In this terms, we also obtained the significance of size and asset profitability. The explanatory power of the Total CaR regression rises from .44 to .68 drawing a remarkable reduction of error components as well.

As we can notice the corrected testing procedures lower the coefficients significance level. Our results support our B-CaRM model since the Total CaR is found significantly related both to idiosyncratic and systematic components.

For both lagged and contemporary models we checked for model robustness by considering both the full and the selected variables models. The substantial stability of the estimated coefficients supports the model robustness hypothesis.

Table 8 Model 1 p-values

Variable	Estimated value	p-value	Corrected p-value
(Intercept)	-6.7771	0.0000	0.0000
lntotass	0.0266	0.6363	0.6799
dtotass	-0.0069	0.1549	0.3265
drwa	0.0121	0.0047	0.0216
dnpl	0.0000	0.8489	0.5722
dtier	0.0077	0.0000	0.0000
lag(roaa)	-0.0303	0.5290	0.5146
lag(overtotass)	0.4780	0.0002	0.0048
lag(llpgl)	0.1378	0.0100	0.0729
factor(year)2010	-0.7161	0.0000	0.0000
factor(year)2011	-0.7831	0.0000	0.0000
factor(year)2012	-0.7438	0.0000	0.0000
factor(year)2013	-0.2539	0.0437	0.0701

Table 9 Model 2 p-values

Variable	Estimated value	p-value	Corrected p-value
(Intercept)	-1.7678	0.0131	0.0774
carsy_bc	0.0281	0.0000	0.0000
lntotass	-0.1396	0.0000	0.0011
dtotass	-0.0035	0.2339	0.3404
drwa	0.0060	0.0224	0.0298
dnpl	0.0001	0.5251	0.5038
dtier	0.0048	0.0000	0.0000
lag(roaa)	-0.0949	0.0014	0.0006
lag(overtotass)	0.2192	0.0024	0.0279
lag(llpgl)	0.0726	0.0251	0.1865
factor(year)2010	-0.4369	0.0000	0.0000
factor(year)2011	-0.3465	0.0000	0.0000
factor(year)2012	-0.3278	0.0000	0.0000
factor(year)2013	-0.0510	0.5136	0.5990

5. Conclusions

The empirical evidences show that, in practice, investors are not completely diversified (Barber and Odean 2000, Barnartzi and Thaler 2001). As a result, investors' risk premium must reflect not only systematic risk but idiosyncratic risk as well. Moreover default risk may increase the probability of bankruptcy so that specific risk can become even more costly. Through the Capital at Risk Model, we propose a method which enable to quantify in one risk premium both the specific and systematic risk.

First of all, if we theorize an evaluation scheme which considers an average production of profits and cash flows, risk premium should include just the unexpected losses which might be arising from the deviation of profits and cash flows from their means. Effectively, investors' expected losses are taken into account by the average profits or cash flows, so that the relevant portion of risk is the downside portion of losses beyond their means: the Value at Risk.

Second, if we have a totally levered firm the downside risk of debtors is the same of the equity holders which reflects the overall assets' riskiness.

In order to apply the Capital at Risk Model, we took the Merton Model to calculate the value of assets, their implicit volatility (to obtain the portion of capital at risk) and the yearly assets' loss (to obtain risk neutral rate of a totally levered firm).

The aim of this paper is to check whether the CaRM model works in the banking industry given the presence of regulatory measures based on VaR methodology. Using Merton Model seems to evident the rational relationship between Capital at Risk and equity standard deviation as a measure of specific risk. The main objective of this paper is to test whether the portion of capital at risk is affected not only by systematic risk, here considered by a transformation of CAPM's beta coefficient, but also by others idiosyncratic variables. Results show a positive relation with change in RWA density, change in capitalization, overheads to total assets and loan loss provisions.

The positive relation with CAPM's beta highlights the ability of the model to determine not only specific risk premium by equity standard deviation, but also the systematic component.

On the whole, we claim that the main strength of the B-CaRM model is that the cost of equity is quantified in the same theoretical framework of the cost of debt coherently with Modigliani and Miller. This setting allows to a more accurate comparison between the required return on equity and debt capital.

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