Banks' Leverage

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Abstract

The main goal of this thesis is that of understanding the banks' financial structure; in the current situation is indeed difficult to understand why banks with similar business strategies adopt highly different financial structure. It has been largely documented in many empirical works that there is a high cross-sectional variation in the financial leverage among peer banks and that, moreover, capital requirements only marginally affect the choice on the corporate structure. In this thesis we try to answer the following question: is there a reason for similar banks, with similar competences and technologies to target different capital structures? Is it because of the Modigliani Miller irrelevance theory or can there be another rational explanation? Is there an effect of regulation on the banks' optimal choices?

In the first chapter of the thesis we review the literature on banks' capital structure. Immediate departs from the Modigliani Miller assumptions, namely a subsidy from deposit insurance, a limited liability issue, the external costs of failures and non contractible actions of banks' managers, all justify in general the need for a regulatory intervention. As the regulator's aim is that of limiting bankers' action, there is a widespread belief that capital requirements should bind the managers' action. As many authors have pointed out, this does not seem to be the case in the real world. The review tries to organize the theoretical and empirical work that has been done on the subject; the main goal is that of summarizing the possible reason of banks' capital structure decisions. We find that all the authors agree in assessing that market forces, other than regulatory forces influence the banks' decision process, but they disagree on the meaning of market forces, what they are and in which way they work. Moreover, there is not yet a consensus over how to model the banks' optimization process.

In the second chapter we study how capital requirements affect banks' capital structure within a standard signaling model. We prove the existence of a separating equilibrium in which capital requirements are not binding for every type of bank, and we show that in equilibrium there exists a negative relationship between bank's leverage and its intrinsic quality: it is the *low* type bank that takes on more debt. This result, in contrast with the traditional theory of corporate finance, sheds some light on some of the recent financial crises episodes and hence questions the effectiveness of the current regulatory environment. We also obtain an interesting result on the effects of capital requirement: while they do not bind in equilibrium, the fact that they might be binding in certain state of the world is a fundamental force for the existence of the equilibrium itself. Put it in another way, without capital requirement there would not be any signaling equilibrium in the market.

Finally, in the last chapter, we conduct an empirical analysis on the cross-sectional determinants of banks' leverage. We find a negative and stable relation between banks leverage and the quality of their assets. This result is proved valid under different

definition of assets' quality, based on ex-ante and ex-post expectation of the realization of asset quality. The results suggest that banks might target a certain leverage ratio to reveal their true quality to the market: the higher quality banks signal their private information to the market with a lower level of leverage, passing over some profitable opportunities to gain from a lower cost of funding.

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Chapter 1

Bank's Capital Structure in Banking Theory

1.1 Introduction

Banks have always been a natural hold out sample from the empirical investigation on firms' capital structures. The basic reason why banks are not included in the traditional analysis is that many of the theoretical frameworks utilized to determine firms' capital structure, in particular those based on asymmetric information, are not directly applicable to banks, whose existence is based on the assumption that they can ameliorate market imperfections. Empirically, banks have always had much higher leverage ratio than non financial firms and this fact created the presumption that banks' and firms' choice variables were different.

A specific literature has therefore focused exclusively on banks capital structure. One strand of the literature has focused on understanding whether capital regulation substantially affects banks leverage decision. It is indeed natural to think that capital requirements, by limiting the size of the investments and hence lower profitable opportunities, should bind banks actions. This is because capital is considered a more expensive way of financing, either because of the deposit insurance subsides or of limited liabilities. If capital requirement binds, it would be shown in the data that a significant fraction of banks choose the lowest possible value of capital. All the authors agree in finding the opposite fact, which is to say that almost none of the banks in the cross-section and over time shows binding capital requirement. In this context, it is possible either that market forces other than regulatory one determines the optimal level of capital, or that regulation modified market forces and hence indirectly influenced banks optimal choice. Osterberg and Thomson (1990), Flannery and Rangan

(2006), Gropp and Heider (2009) are all recent papers that address this issue. These papers generally agree in stressing the importance of market variables in the choice of leverage, while they disagree in estimating the effect of regulation.

A different approach in analyzing the determinants of banks capital structure is taken in other papers, as in Marcus (1983), Berger (1995) and Mehran and Takor (2009); these papers follows more closely the empirical works testing the trade-off theory for firms; indeed, they attempt to explain banks' capital ratios independently from the regulatory constraint. There are many factors that, as well as for firms, have been proved statistically significant in explaining the cross-sectional variation of leverage; particularly interesting is the positive relation that most authors find between banks' profitability and leverage: in many empirical works it is shown that shareholders profitability (measured in different ways - ROE, net profits,..)is negatively related to leverage. A third strand of the empirical literature on banks' capital structure focused in understanding the role of capital buffers. The capital buffer is the amount of capital a bank holds in excess of the regulatory requirement. We have already noted before that almost the entire totality of banks hold more capital than requested; on the basis of this observation, three empirical questions can be asked: first, why do banks hold a buffer of capital? Second, how does this buffer vary over time? Third, how does this buffer vary in the cross-section of banks? Empirical papers typically address one question at a time; the first question, on the reasons for capital buffers, is partly explained by the models cited before (Osterberg and Thomson (1990), Flannery and Rangan (2006), Gropp and Heider (2009)) that evaluate the effects of market forces in the leverage choice. The time series analysis of capital buffer is often recollected to the issue of the pro-ciclicality of the Basel regulation: in these papers the authors want to understand how the buffer co-moves with the business cycle.

Banks operate in one of the most regulated sector among all. While the theoretical literature is divided among the optimal design of regulation, it is well established in practice the use of a capital requirement constraint. Beside few models that include in the banks optimization problem some variables that increase the cost of leverage (such as charter value or ex-post fines applied to not enough capitalized banks), the theory on capital requirement is generally unfit to explain the cross-sectional determinants of banks capital structure. For example, all those paper that justify capital requirements with the risk shifting incentive of deposit insurance, must consider that capital requirement are always binding. The deposit insurance scheme indeed subsidizes banks that pay a risk-free interest rate on their funding. Since liabilities are not fairly priced by the market, the average cost of capital is decreasing in the level of debt; in models that include the limited liability option and the deposit insurance option, the banks' incentive to increase their leverage ratio is exponential; any regulation that limit directly or indirectly the leverage of banks will therefore be binding.

Until recently, studies have focused attention on responses by a representative bank to regulation. This is only the starting point of the research debate: the real world is indeed characterized by a variety of banks that differ, for example, in management capabilities and technological sophistication. The studies that incorporate a feedback effects between bank-level choices and market-level outcomes are at initial stage, and its development will surely lead to a clearer picture of the effects of capital regulation over banks capital structure.

The structure of the paper is as follows: in section 2 we review the major evidence on banks' capital structure; we distinguish among the papers on the basis of the endogenous variable they are looking at and we outline the basic result of each paper. In section 3 we describe the implications of the literature on banks' regulation over the choice of capital structure and we explain why those models are unfit to describe the optimal capital structure of banks. In section 4 we analyze some of the recent contributions on banks capital structure; in the last section, we conclude.

1.2 Empirical Literature

There exist a vast literature on the empirical determinants of firms capital structure. The two most challenged theories that are tested (usually one against the other) are the pecking order and the trade-off theory. Although a see deep amount of paper has been written, the researchers keep disagreeing on which theory helps better in explaining the firms' financial behavior. As an example, two relevant and recent contributions on this issue, one by Flannery and Rangan (2006) and the other by Shyam-Sunder and Myers (1999) reach to opposing conclusions: the first shows that a model of partial adjustments with firm fixed effects fits very well the data; this result is in favor of the trade-off theory. The second, instead, finds that the pecking order theory has a higher prediction power as it is correctly rejected when false, while the same is not true for the trade-off theory.

Banks have always been a natural hold out sample from the investigation on firms' capital structures. The basic reason why banks have not been included in the traditional analysis is that many of the theoretical framework utilized to determine firms' capital structure, in particular those models based on asymmetric information, are not directly applicable to banks, whose existence is based on the assumption that they can ameliorate market imperfections. Empirically, banks have always had much higher leverage ratio than non financial firms and this fact created the presumption that banks' and firms' choice variables were different. A specific literature has therefore focused exclusively on banks capital structure.

There are two point of views in the studies on the capital structure of banks (and of firms in general). One one side, one can ask how the capital structure of a panel data of banks evolved trough time; following this approach, the first research question that can be asked is whether and in which ways the regulation has modified the banks' capital structure trough time. Similarly, some model based on a time series analysis, tend to capture the links between capital structure and the business cycle fluctuations. The other perspective consist in understanding the determinants of optimal capital structure for each bank; these models are generally based on a model of target leverage, as those used in the empirical test for the trade-off theory for firms, and include among the regressors different variables that relate to the theory they want to test.

One strand of the literature has focused on understanding whether capital regulation substantially affects banks leverage decision. It is indeed natural to think that capital requirements, by limiting the size of the investments hence profitable opportunities, should bind banks actions. This is because capital is considered a more expensive way of financing, either because deposit insurance subsides or because of limited liabilities. If capital requirement binds, we should be able to find in the data a significant fraction of banks that operate with the lowest possible value of capital. All the authors agree in finding the opposite fact, which is to say almost none of the banks on the cross-section and over time shows binding capital requirement. In this context, it is possible either that market forces other than regulatory one determines the optimal level of capital, or that regulation modified market forces and hence indirectly influenced banks optimal choice. Osterberg and Thomson (1990), Flannery and Rangan (2006), Gropp and Heider (2009) are all recent papers that addressed this issue.

Osterberg and Thomson (1990) propose an empirical analysis of the determinants of the leverage ratio for a panel of bank holding companies (BHC). The empirical investigation is carried out following a theoretical model which the authors develop as an extension to the Bradley, Jarrell and Kim (1984) model of optimal leverage, essentially a trade-off model. The trade-off is given by balancing the tax advantages of debt against the expected costs of debt, that include the expected costs of breaching the capital requirement constraint. There are two main results of this paper: on one side the authors prove that optimal leverage for a bank facing a possible capital penalty is less than it would be for the same bank without capital constraint (potential explanation for capital buffers); on the other, that an increase in the capital requirement reduces leverage only when bank expects to be able to meet the capital requirement. When capital requirement is set at a level a bank does note expect to be able to meet, on average, then the bank may actually increase its leverage. Their empirical analysis proves that both market influences and regulatory influences affect the determination of banks' leverage; tax rates, nondebt tax shields and loan-loss provisions impact the leverage decision as well as book capital regulation and portfolio risk.

In April 1999 a working group of the Basel Committee on Banking Supervision (the entity that defines the international framework for banks' regulation) issued a paper in which they reviewed all the existing findings on banks' behavior following the introduction of the Basel Accord. They reviewed, in particular all the papers that looked at whether regulatory capital requirements induce banks to hold higher capital rations than would have otherwise been the case. Overall, the literature on the effectiveness of capital requirements does provide evidence that when banks' capital ratios have fallen below the regulatory minimums, on average such banks have subsequently tended to increase their capital ratios more rapidly than strongly capitalized banks; at the same time, though, no paper has been able do demonstrate conclusively that capital requirements leaded banks to hold higher capital ratios. However, there is a broad consensus among the studies that banks with relatively low capital ratios have tended subsequently to boost these ratios. In contradiction to Gropp and Heider (2009), the literature find a significant effect of regulation on the lowest capitalized banks.

The majority of the paper reviewed in this section employ the same econometric model, a static model of banks capital structure, for the regression. An alternative approach was introduced by the model developed by Flannery and Rangan (2006): the model accounts for a potentially dynamic nature of a bank's capital structure. The model allows each bank's targeted leverage to vary over year and allows for deviation from the optimal target. Deviation may be well economically justified by external costs of adjustment: due to this cost, banks can indeed decide to move toward their desired leverage target through time and to close each period a fraction λ of the gap between desired and actual leverage. With this particular model the authors find evidence that firms converges toward its long-run target at a rate of more than 30% a year and that a partial adjustment model with firm fixed effects fits the data very well. The goal of the paper is however to understand what are the determinants of the bank capital build up of the 1990s; there are three possible explanation of this phenomena: on one side, the capital buildup can be due to a passive approach of managing capital in times when returns have been high (hence retained earnings feed capital dynamically); another possibility is that capital requirement and supervisory pressure forced banks to increase their capital; finally, market forces, as perception of banks' implicit guarantee and probability of default, could influence the way banks decide among the optimal capital structure. The authors provide an empirical test on these three alternative hypothesis and conclude that the strongest driver in the capital buildup can be attributable to market forces; coherently with other findings, regulation seems of secondary importance (at least in a direct way).

In a different paper, Gropp and Heider (2009) find that the general variables used to explain the cross-sectional variation in firms' leverage are valid also for the banking sector. The sample of data observed contains the 100 biggest European and American banks, ranked by market capitalization. The regression model used is a standard corporate finance model that relates leverage to some banks' specific factors, such as profitability, size, dividend policy and unobserved fixed effect. Accordingly to the general corporate finance findings, they prove a positive relation between leverage, banks size and value of the collateral, while a negative one with banks profitability, market-to-book ratio and dividends. The authors main conclusions regards primarily two points: first, they find a significant explanatory power of banks' unobserved fixed effects; second, that capital requirement regulation (based on the effective risk taken) is only a secondary factor in the determination of banks leverage, as including a risk variable in the regression does not modify at all the standard determinants defined in the corporate finance literature. The findings on banks fixed effects could be driven by a bias in the sample selection, due to the inclusion of American and European banks altogether; differences in accounting standards adopted by the two groups of banks imply a significantly different quantification of the balance sheet. While the differences affects univocally the measured level of leverage, resulting in a higher leverage ratio for European banks, the implications on the income statement are not necessarily mono-directional. Since the dependent variable and the regressors can be affected asymmetrically by the accounting rules, there is a motive for a fixed effect bias.

A different approach in analyzing the determinants of banks capital structure is taken in other papers, as in Marcus (1983), Berger (1995) and Mehran and Takor (2009); these papers follows more closely the empirical works testing the trade-off theory for firms; indeed, they attempt at explaining banks' capital ratios independently from the regulatory constraint. There are many factors that, as well as for firms, have been proved statistically significant in explaining the cross-sectional variation of leverage; particularly interesting is the relation that most of the authors find between banks' profitability and leverage: in many empirical works it is shown that shareholders profitability (measured in different ways - ROE, net profits,..)is negatively related to leverage.

One of the first contribution in the study of banks capital structure is Marcus 1983 paper that conducts a time series analysis of the impact of interest rate on leverage. The author tries to explain the strong increase in banks' leverage between 1961 and 1978; in that period, the capital to asset ratio decreased indeed from 11.7 percent to 5.7 percent to reach level as low as those seen during World War II. The author tests the impact of nominal interest rate increases on banks optimal leverage decision. Leverage is seen as the optimal solution to the trade off between benefits and costs of leverage itself, coherently with the hypothesized classical trade-off theory. Benefits of leverage derive from the the tax shield and from the value of the deposit insurance (when insurance premium is not fairly identified); on the other side costs are due to higher probability of default and to regulatory pressure for adequate capital which can result in direct costs for the bank. At the optima, the marginal effect of those two forces is compensated. Default is costly in a double sense: directly, as there are some direct costs due to failure (for example legal costs), and indirectly, because of the loss of potential charter value (i.e. the net present value of all future rents). The author shows that an increase in nominal interest rate can influence the marginal balance between regulatory costs and tax advantages: while tax advantages are indeed constant to changes in the interest rate, the net present value of regulatory cost decreases (because of a higher discount rate). If this trade-off theory holds, it should therefore be the case that higher level of leverage are accompanied by higher level of the interest rate. The author specifies a model of partial adjustment in which the endogenous variable is the capital to non cash assets; the exogenous variable are represented by the nominal interest rate, the tax advantage of deposit relative to equity, a variable capturing regulatory pressure, a dummy fro national banks, bank size and interest rate volatility. The estimated coefficient on the interest rate is negative and large enough to account for significant change in the capital ratio. This trade-off theory seems therefore confirmed in the data sample.

In a less recent analysis, Berger (1995) studies the relationship between capital-to-asset ratio (CAR) and the returns on equity of US banks and finds a positive relationship, both statistical and economical, that holds both cross-sectionally and for each year, when lags are included and that becomes even stronger when an extensive set of control variables is added to the regression. More importantly, Berger tries to determine a potential explanation of this (counterintuitive) finding; under the assumption of perfect markets, there should be a negative relation between CAR and ROE, since higher CAR reduces the risks on equity and therefore lowers the market's required rate of return. When we relax the single period framework and we assume that earnings are retained instead of paid out (as in the pecking order theories) , we obtain a positive relationship between the two variables; similarly, when perfect information is relaxed, there is a possibility for a signaling equilibrium in which better quality firms signals trough higher capital. This paper tests which of these two possible explanation is more able to explain the observed data. Particularly interesting is the author's analysis of the signaling hypothesis, which he interprets as the attempt of bank management to signal private information that future prospects are good by increasing capital; following this interpretation of a signaling equilibrium, an increase in CAR should be followed by either higher revenues, lower operating income or lower risk of the assets. The author tests whether there is an improvement in either revenues or operating costs following capital increases and finds no evidence of signaling. Moreover, he finds no difference between the results obtained for banks that actively manages their CAR and banks that behave only passively (trough earnings retention); this again is an evidence against signaling as that requires that the capital decision is a voluntary optimal choice. Overall the author finds dividends do not fully respond to changes in earning so part of earning changes accumulate in to changes in the level of capital. This prediction would support the pecking order hypothesis.

Mehran and Thakor (2009) propose an analysis of the relationship between bank value and leverage and find a strong and statistically significant relation between the goodwill paid in some recent M&A transactions and the capital to asset ratio of the targeted bank; they conclude that banks value, captured by the goodwill, depends positively on the capital ratio: good banks (for which an higher goodwill was paid) tend to have a lower leverage ratio. They interpret this result following a theoretical model developed in the paper; the main proposition of the model affirms that in equilibrium better quality banks are those with a higher capital ratio: capital has indeed a positive direct effect on the bank's value trough increasing the probability of survivorship, and an indirect one trough an increase in the incentives of loan monitoring. Monitoring incentives increase as forward looking managers perceive higher benefits from monitoring when capital is higher, as the probability of the banks default is lower (hence a higher probability of being remunerated in the future). A stronger monitoring of loans implies in turns an higher quality of the assets.

Mehran and Thakor conduct their empirical analysis upon a sample of banks that have recently been part of an M&A deal as targets. The authors use the ratio of goodwill, a measure of the difference between the price paid and the market value of equity (which in turns represents the difference between the market value of assets and liabilities), over total assets as a proxy for banks value. In practice though the price paid in acquisitions could well be affected by other economic factors than the intrinsic quality of the purchased assets; this factors can include the evaluation of positive synergies (economies of scale and scope), can derive form a higher monopolistic rents, from managements empire building attitude and/or from the gains of becoming a too-big-to-fail institution.

The evaluation of the relation between leverage and monitoring incentives is the topic also of Bouwman (2009). The author test the generally accepted theory that better capitalized banks have more screening and monitoring incentive and therefore better profitability (because of lower loan allowances). An empirical attempt of studying the relation between the capital structure and monitoring can suffer of the reverse causality problem: if it is true that higher capital improves the monitoring incentives, and thus lowers loan default and improves performance, it is in practice possible that better bank performance (due to other factors not included in the model) increases earnings and hence higher capital through earnings retentions. To overcome this issue, the author test the implication of capital structure on the monitoring incentives in the contest of banks mergers and acquisitions; in particular the author tests whether changes in capital structure (due to a merger) affect the level of monitoring. Assuming that monitoring are a decreasing return to scale technology, the author tests whether the combined level of monitoring associated with the new capital ratio is higher than the combined incentives the two banks had before the merger. The regression results show that the greater the increase in capital at the target bank due to the merger, the greater is the improvement in performance at the merged bank relative to the pro forma performance of the combined bank prior to the merger. Specifically, an increase in target capital due to the merger reduces post-acquisition net charge-offs and non-performing loans and significantly increases post-acquisition ROE. The author takes this result as a proof of the positive relation between capital and monitoring incentives.

A third strand of the empirical literature on banks' capital structure focused in understanding the role of capital buffers. The capital buffer is the amount of capital a bank holds in excess of the regulatory requirement. We have already noted before that almost the entire totality of banks hold more capital than requested; on the basis of this observation, three empirical questions can be asked: first, why do banks hold a buffer of capital? Second, how does this buffer vary over time? Third, how does this buffer vary in the cross-section of banks? Empirical papers typically address one question at a time; the first question, on the reason of capital buffer, is partly explained by the models cited before (Osterberg and Thomson (1990), Flannery and Rangan (2006), Gropp and Helder (2008)) that evaluate the effects of market forces in the leverage decision. The time series analysis of capital buffer is often recollected to the issue of the pro-ciclicality of the Basel regulation: in these papers the authors want to understand how the buffer co-moves with the business cycle.

Berger et al. (2008), Jokipii and Milne (2006) and Ayso et al. (2004) all propose recent studies of the banks' capital structure aimed at explaining the compelling (from a theoretical point of view) phenomena of capital buffers. Bank holding companies hold capital in excess of the minimum capital standars by material amount in every period between 1992 and 2007. At the same time the leverage ratio is 100 basis point higher in 2006 than it was in 1992, while the risk based ratio has almost been flat throughout time. Since capital requirements limit the investment opportunity of banks and their profitability, it is commonly believed that should bind banks' decision. It is therefore an interesting question to ask why capital requirements are not binding for the majority of banks.

Berger et a.l. (2008) test whether banks target a specific capital ratio above regulatory requirement or if that buffer is a mere consequence of a positive series of accumulated earnings. The authors test which of an active and passive contribution is stronger in the formation of capital buffers; management could actively choose a given buffer that reflects the economic capital, that capital actually needed to contrast the bank's actual risk exposure, and the best reaction to catch potential growth opportunities, or passively (less voluntarily) just retaining past year incomes. The authors find a significant evidence that an active management approach subsist in the observed panel of data; capital buffer appear to be a mean reverting process in which the speed of convergence is proportional to the distance from the target. Jokipii and Milne (2006) focus their empirical investigation in understanding the relation between capital buffers and the business cycle; they find a significant negative co-movement of buffers and the business cycle. Following years of economic stability, banks tend to lower their buffer while increasing it when times turn bad (probably because their risk management tool are all fed with historical and recent data). As the authors note, this fact goes to amplify the pro-cyclical prescription of the Basel II regulation. Similar research questions and similar answers are found by Ayuso and at. (2004) using data from Spanish banks

1.3 Literature on banks regulation

Banks operate in one of the most regulated sector among all. While the theoretical literature is divided among the optimal design of regulation, it is well established in the practice that regulation takes the form of a capital requirement constraint. One fundamental justification for banks capital requirement is the moral hazard problems introduced by the deposit insurance; simply put, the insurance scheme give a put option in the hands of managers to sell the banks assets whenever their value is lower than that of liabilities. Since the value of the put option is increasing in the volatility of the assets, managers have the incentive to shift the composition of the asset portfolio towards riskier assets. One way to deal with the moral hazards is to link the bank's shareholders' capital infusion to the risk of the bank. This imposes a cost on the shareholders for increasing the bank's failure probability through higher asset risk and permits the regulator to control the bank's portfolio choice. the bank. Because the insurance provider charges banks a flat insurance premium it gives them an incentive to increase risk.

A problem with this rationale for capital regulation is that when markets are complete and there is no information asymmetry the need for deposit insurance is unclear and when it exists it can be appropriately priced, which eliminates the risk-shifting incentive. This led researchers to start studying capital regulation in incomplete market settings. Some researchers adopted the portfolio approach of Pyle 1971 and Hart and Jaffee 1974, which models the bank as a portfolio of securities. Bankers choose the composition of their portfolios in order to maximize the expected profit for a given level of risk, taking the yields of all securities as given. Koehn and Santomero 1980 and Kim and Santomero 1988 adopt this approach and assume, as a proxy for the incompleteness of markets, that bankers are risk-averse and therefore maximize a utility function of the bank's financial net wealth. A possible justification for this proxy is that the bank is owned and managed by the same agent, which cannot completely diversify the risk. The introduction of a flat capital requirement restricts the risk-return frontier of the bank, forcing it to reduce leverage and to reconfigure the composition of its portfolio of risky assets. This may lead to an increase in the bank's probability of failure because the banker may choose to compensate the loss in utility from the reduction in leverage with the choice of a riskier portfolio. Regulators can eliminate this adverse effect by requiring banks to meet a risk-based capital requirement instead.

The conclusion by this literature that more stringent capital standards could lead to an increase in the bank's risk of failure drew a great deal of attention, but it was subsequently questioned on several grounds. Rochet 1992 questions two features of the Pyle Hart model adopted in this literature. Bank capital is treated in the same way as any other security, implying that banks can buy and sell their own stock at a given price, regardless of their investment policy, and banks choose their policies as if they were fully liable. Rochet shows that when limited liability is taken into account and bank capital is exogenously set at a certain level, the convexity of preferences due to limited liability may dominate risk aversion, and the bank, if undercapitalized, will behave as a risk lover. In this case, even a risk-based capital regulation that makes use of "market-based" risk weights that is, weights proportional to the systematic risks of the assets as measured by their market betas, may not be enough to restrain the bank's appetite for risk. It may be necessary to impose an additional regulation, for example, to require banks to operate with a minimum capital level.

The theory of bank capital requirement that analyzes the effect of the requirements over bank's riskiness and stability is however very vast[1] and generally reaches different and contrasting conclusions. The literature can be organized around basic modeling approaches; in the first approach banks are modeled as managers of portfolios of assets. The seminal analyses of the portfolio impact of capital requirement (as in Koehn and Santomero (1980), Kim and Santomero (1988)) assumed an always binding capital requirement. In particular those papers evaluate the effects of a binding leverage constraint on the probability of failure when banks are risk averse agents. They proved that a tightening of the leverage ratio constrains the banks' efficient asset investment frontier that implies an alteration on the mix of assets in portfolios: less risk averse banks respond by choosing a riskier asset mix than before (risk shifting incentives of unfairly calculated weight on the assets-given the amount of money to invest, some banks can decide to invest in those that minimize their cost of capital).

Another approach in investigating the effects of capital requirement is that to consider banks as forward looking optimizers balancing the benefits and cost of regulation; this approach generally agrees on considering a binding regulation. An exception is Calem and Rob (1999) that consider the effects of an ex-post surcharge/fine for those banks breaching the constraint: the effects of ex-post surcharges can indeed justify the existence of a capital buffer. Similarly, Milne (2002) argues that the main effects of capital regulation operate through banks' efforts to avoid ex post penalties imposed by regulators if violations of capital adequacy standards take place. In Santos (1999) two

[1]For recent reviews of the theory of capital regulation see Battacharia, Boot and Marnic (1997), Santos (2000) and VanHoose (2007)

sources of moral hazard exist simultaneously: one issue involving the bank relative to the deposit insurance provider and another involving the borrower and the bank; in this contest bank capital is more expensive than deposits (due to the deposit insurance) and banks always choose the minimum capital level specified by the regulators and hence are always bound; capital regulation unambiguously reduces bank risks. Finally, the last approach is that of examining the role of asymmetric information as a factor influencing the effects of capital regulation on bank decision making. Models based on a representative agent fail to explain the feed back effect between bank level choices and market level outcomes; they fail also in explaining the cross-sectional behavior of bank, we have shown that in most of that literature capital requirements are binding for all the market participants.

The effects of regulation on banks' investment decision and riskiness has been widely studied in the last twenty years. Nevertheless, most of the model reach to different conclusions for the consequences of banks behavior and risk. Some academic contribution indicates that capital requirement unambiguously improves the bank stability while other works concluded that, if anything, they make banks riskier institution than they would be. Beside few models that include in the banks optimization problem some variables that increase the cost of leverage (such as charter value or ex-post fines applied to not enough capitalized banks), the theory on capital requirement is generally unfit do explain the cross-sectional determinants of banks capital structure. For example, all those paper that justify capital requirements with the risk shifting incentive of deposit insurance, must consider that capital requirement are always binding. The deposit insurance scheme indeed subsidize banks which pay a risk-free interest rate on their funding. Since liabilities are not fairly priced by the market, the average cost of capital is decreasing in the level of debt; in models that include the limited liability option and the deposit insurance option, the banks' incentive to increase their leverage ratio is exponential; any regulation that limit directly or indirectly the leverage of banks will therefore be binding.

When capital requirements bind for any banks, the capital structure becomes an uninteresting issue as it is directly given by the binding constraint. If the constraint is represented by a risk weighted capital requirement, as it is in the Basel framework, then the capital structure is entirely driven by the level of risk of the assets. Therefore, banks with similar exposure to risk should have similar leverage ratios. We have seen in the previous section that the empirical facts strongly contradicts this theory as capital requirements are generally not binding and the cross-sectional variation of leverage is high even for bank with similar assets. Some models have introduced the logic that market forces, other than direct forces, affect the capital structure; so, for example, the positive probability of incurring in ex-post fines for being lowly capitalized can induce banks to hold a buffer of capital. While these models help contributing to explain why bank hold buffer, still they are unable to detect first order factors that drive the banks' cross sectional optimal level of leverage.

Until recently, studies have focused attention on responses by a representative bank to regulation. This is only the starting point of the research debate: the real world is indeed characterized by a variety of banks that differ, for example, in management capabilities and technological sophistication. The studies that incorporate a feedback effects between bank-level choices and market-level outcomes are in an initial stage, and its development will surely lead to a clearer picture of the effects of capital regulation over banks capital structure. Blum (2007) presents a model of optimal regulation in the presence of asymmetric information. The regulator is here not able ex-ante to detect banks quality, but has the ability to detect ex post dishonest behavior and hence to impose sanctions. When this ability is limited, the imposition of a leverage ratio can be an optimal instrument to induce truthful revelation. The leverage ratio makes the risk related regulation incentive compatible as it reduces the banks gains from understating their risk in a double direction: it reduces the put option value connected with limited liability and it increases the size of the fine that can be applied. It is interesting to note that the author finds that in the absence of ex-post sanction, risk sensitive capital requirement do not induce self-revelation. It is therefore possible in this model that capital requirement do not bind banks' decision as banks try to mislead market perception about their true quality.

Finally on this strand, Boot and Marnic (2007) focus the analysis on the impact of capital regulation on market competition and on the feedback effect of market condition on the banks optimal behavior, hence verifying the effectiveness of regulation. The banks are assumed to differ in the ability of monitoring potential borrowers; the monitoring moreover determines the probability of project success. Banks compete to acquire borrowers and market share in a Bertrand competition, based upon which they will need to choose the optimal monitoring technology to acquire at a fixed cost. In this context, capital requirements always have a cleansing effect on the industry by reducing the deposit insurance subsidy for lower quality banks, thereby reducing their competitive strength, while the effects on entry are ambiguous: increasing costly capital requirement can encourage entry in the market. At intermediate levels of quality and sufficiently high degrees of competition, a banking system open to entry could experience a reduction in monitoring incentives. Thus, the impact of capital regulation on aggregate loan quality is ambiguous.

In conclusion, banking theory of capital requirement is generally unfit to explain the consequences of regulation on banks' capital structure. The main proposition of the majority of the papers assume that the regulation will always binds banks' decision; the capital structure becomes a second order event in term of importance in banks' actions. The additional limit of this models is that of considering that the irrelevance of the capital structure of each single bank determines an irrelevance of the capital structure of the financial system. Banks capital structure is given by the amount of specific risk of the assets; no importance has been put on the systemic risk component. But the level of leverage of the entire financial system (which is given by the sum of the leverage of single banks) greatly influence the level of market and funding liquidity of capital markets, hence asset prices and systemic risk. A new strand of the literature is trying to define an alternative capital regulation that limits the effect of the systemic risk on the fragility of the financial system[2]. These papers take directly into account the relevance of banks capital structure on systemic risks.

1.4 Theory of banks' financial structure

A strand of the banking theory has focused extensively on banks' capital structure, mostly independently from regulation.

Marcus (1984) analyses in a theoretical model the counterbalancing effects of a mispriced deposit insurance and a positive charter value on banks optimal decision over leverage and asset risk. A bank charter value can indeed be positive if limitations on entry into the industry enable banks to obtain deposits or make loans at advantageous rates. As shown in Merton (1978), the value of equity is increasing in the level of leverage since deposits are insured and their market value is unaffected by changes in the banks riskiness. Including the charter value in the evaluation process, the effect of increased capitalization on bank owners' wealth is indeterminate: increased equity reduces the probability of default and the associated loss of charter while reducing the benefits from the FDIC insurance on deposits. It is shown that for charter high enough, the benefits compensate the losses. Moreover, for a given charter, the equity value is increasing in leverage when the level of capital is already very low: banks that are already very likely to default prefer to battle for resurrection than recapitalizing their positions. The opposite is although true for well capitalized banks, whose equity value is decreasing in leverage as leverage reduces the probability of conserving the charter. The optimal financial structure of banking, assuming no regulation and deposit insurance not fairly prices, is therefore given by the trade-off between the benefits of the insurance and the loss of charter; the optimal leverage target will vary in the cross-section accordingly to the initial level of capital.

Lucas D. and McDonald R.(1992) develop an interesting model that rationalize banks' holding of risk-free assets; this behavior is in general not explainable under the assumption of banks' risk neutrality in presence of deposit insurance. Deposit insurance provides an incentive to invest in the riskiest assets because its value is increasing in assets' volatility. When market is imperfectly informed about the quality

[2]For more details please read Morris and Shin (2007), Adrian and Shin (2009) and Acharya (2001).

of banks loans, the authors prove the existence of a separating equilibrium in which better quality bank reveal themselves trough the holding rislkess assets; in equilibrium the loss of value of the deposit insurance is compensated by the reduction in the cost of financing trough risk sensitive debt. Moreover, the reduction in the cost of borrowing is more beneficial for good bank than it would be for bad bank as their probability of default is lower. The precautionary demand for marketable securities protects bank from entering a market characterized by adverse selection. The implication for the financial structure are a bit more controversial; the authors define an exogenous capital structure at the beginning of the game in which banks are assigned a given level of deposits (endowment) that can be invested either in loans or assets; equity is normalized to zero and and no capital requirement is therefore considered. The authors assume in each of the following period that banks face an exogenous liquidity shock that increases or decreases their deposit base; if deposits are reduced and decide not to reduce the size of the assets, the unique alternative form of financing is trough risky borrowings. The main assumption of the authors is that when the amount of borrowing the banks decide to emit in the market perfectly compensate for the exogenous shock received in deposits; this assumption is justified with the introduction of a capital requirement that limits the incentive for banks borrowing. As so, the size of the assets and the leverage ratio is constant among banks and over time; only the composition of leverage changes as deposits are substituted with market debt.

Flannery (1994) analyzes the optimal composition of banks liability structure and find a rational explanation for the high roll-over risk that banks incur; the capital structure of banks is indeed peculiar with respect to that of other firms in two aspects: banks work with a much higher leverage and in addition they issue liabilities with shorter maturity then their assets. Since many financial-firm assets are illiquid, this short funding exposes them to substantial liquidity risk. Flannery proves that this source of short term borrowing is actually the optimal form of market reaction to banks asset substitution: since banks can modify the composition and risk structure of their assets very easily and in a small amount of time, the unique form of contractible debt is a very short debt that fairly prices any change in asset composition on a roll-over basis. Liquidity risk thus reflects a bank's optimal response to the problem of financing its asset portfolio. Its analysis is based on the Merton (1978) model of firm value option pricing; similarly to the Modigliani Miller framework, capital structure becomes irrelevant also in the presence of risky debt, as long as information is symmetric. Leverage though, generates distortion in the investment incentives: instead of accepting only positive NPV projects, the bank might well invest in negative NPV project with high volatility; volatility increases indeed the value of the put option due to limited liability. Distortions are however fairly priced by the market and reflected in the premium required to hold the asset. For financial firms this cost is even bigger as the true risk of bank assets is not readily verifiable by outsiders and bank asset risks are observable but not contractible due to the high opportunity to change the asset composition. Given the costs uninsured bans would encounter in employing covenants there seems to be an unusually important role for short-term debt in banks' optimal capital structure. The model, however, does not describe the leverage ratio per se (as based on a MM framework and reaches to the irrelevance of capital structure) but explains the implications between bank activity and liability composition.

Merton and Bodie (1995) suggest that financial systems should be analyzed in terms of a functional perspective rather than an institutional perspective; functional perspective is one based on the services provided by the financial system, on what banks do in their typical activity. Diamond and Rajan (2000) is a perfect example of a theory based on the functional form of financial intermediaries; there are two functions exploited by banks: on one side they collect money trough deposits, on the other to lend money to entrepreneurs. The authors argue that it is possible to understand a bank capital structure only if we identify what role capital plays within the functions the banks perform. On the lending side, banks lend money to entrepreneurs that invest it in a real project. The entrepreneur has a specific ability vis á vis his project so that the cash flows he generate exceed what anyone else can achieve; projects are illiquid because the entrepreneur can not commit his human capital to the project, in which case liquidation takes place at a liquidation value, lower than its fair value. Similarly, banks have a higher ability in monitoring their loans that results in better liquidation treat; therefore also banks can decide to threat investors by removing their personal skills, in order to capture higher rents from investors. For this reason also the banks face a liquidity issue, in the sense that they can't raise the full present value of expected cash flows from investors. Banks can solve this liquidity problem by financing trough deposits; deposits are fixed claim with a sequential service constraint where depositors get their money back in the order in which they approach the relationship lender until he runs out of money or asset to sell. As so, depositor would react with a run to the bank's attempt to withdraw its skills. A run imposes big losses to banks: a bank will always prefer avoiding runs. Banks maximize the amount of credit it can offer by financing with a rigid and fragile all-deposit capital structure. When returns on the real project are random, we can possibly foresee a run although banks did not attempt an opportunistic behavior, just because they expect not to be repaid in full. To avoid runs, bankers could try to raise capital; capital has the advantage of being a banks' buffer against shocks to asset value and can protect against a run. At the same moment capital increases the rents the bankers can extract: capital holders do not have the option of threatening of renegotiating. The trade off between benefits and cost origins the optimal capital structure: the demandable nature of deposits is crucial to explaining banks' optimal capital choices. The potential for a deposit run serves to discipline the bank and the main role of capital is to give a bank a party with which it can negotiate when a bad outcome occurs. An implication of this model is that a bank's leverage ratio should increase when the underlying ability to liquidate the projects at fair value increases; the higher the haircut applied to liquidate the asset, the higher are the rents that entrepreneurs can try to extract form the bank.

The goal of Barrios and Blanco (2003) paper is to understand whether regulatory capital requirements induce banks to hold higher capital ratios than would otherwise have been necessary. The authors assume that capital requirement can be non-binding only if banks are subject to market forces that force banks to maintain higher capital than the regulatory one. The model assumes that banks invest in multi period projects with random return and are financed with an exogenously given level of capital and insured deposits. Deposits cause the bank to incur two other costs, the deposit insurance cost, the premium applied in order to insure deposits and operating cost, such as intermediation costs due to the provision of transaction and liquidity services attached to deposits. Bank can moreover increase capital in the following period (while the size of investment is not considered). The presence of this costs, and their convexity, allows for an internal optimal capital structure. In a second step, regulation is introduced; the divergence between the regulatory minimum capital and the corresponding optimal market capital responds to a different conception between supervisor and bank with respect to the level of solvency. When the regulator imposes sufficient sanctions to the banks that overcome the limits, the bank will hold a capital buffers. The buffer is intended to limit the effects of a negative realization of returns; the amount of cushion depends on the sanction costs and on the current capital ratio. The two alternative models are tested with market data from Spanish banks; the outcome shows that the probability of belonging to the market model is higher than that of belonging to the regulatory model. Hence, regulatory constraint is one of the factors related to capital augmentation but it is not the most important one.

Gan (2003) presents a model of banks' financing and allocation optimal choice. In contrast with the prediction of the banking regulation literature that capital requirements always binds because debt is cheaper than equity, the authors propose a trade-off model with an interior solution for leverage. The optimal level of leverage is given by trading off the benefits of leverage, such as exploiting government insurance value, and costs, such as an increase in the probability of default that reduces banks charter value (i.e. the net present value of future rents). In the model banks are financed with equity and risk-free deposits, and can invest into two different securities: a NPV positive loans (whose production function shows decreasing return to scale, hence decreasing rents) and some zero NPV trading assets; assuming perfect information between managers and shareholders, banks maximize the final wealth of shareholders, that is a function of the sum final value of the assets, the value of the put option given by limited liability and insurance premium, and the present value of growth opportunities. When banks invest uniquely in marketable securities they will chose the maximal level of leverage and risk allowed (since these assets generate zero charter value); on the contrary, when banks invest in loanable securities, the optimal choice of risk and leverage is decreasing in future investment opportunities (hence there exist a local optimum). In an unconstrained world without capital requirements, banks that invest in both the mentioned assets will tend to chose the maximum size of leverage and risk, as the gain from the deposit insurance dominates, when the size of bank is big enough, the loss of current and future investment opportunities. This global optimum corresponding to the maximal leverage is not a social optimum; a regulation can therefore be enforced to limit the social costs of failure. In presence of capital requirement, bank's size cannot exceed certain limit; as a consequence, the value of the deposit insurance is capped at a certain value. The trade-off between cost and benefits of leverage is therefore influenced by capital requirement: the banks can compare now their benefits of working at the maximum level possible, or choosing an interior optimal. In some cases regulation cut off the global optimum and induces banks to choose their local optima. This model is able to explain the role of buffers in banks capital structure: the buffer is indeed the consequence of a interior optimal solution of the banks capital structure, given by the trade-off between charter value and deposit insurance.

Allen, Carletti and Marquez (2008) show that market forces can lead banks to hold levels of capital well above regulatory minimums even when capital is relatively costly. The model is based on a functional form of bank that lends to firms (that have access to a risky investment) and monitor them; at the same time banks can collect funds in the form of equity and deposits. The authors assume that bank capital is a more expensive form of financing than deposit. Monitoring is an activity that improves the performance of firms (by increasing the probability of success); at the same time monitoring is a costly activity. The cost of monitoring and limited liability creates a moral hazard problem for banks. In this framework, capital can work as an incentive to monitor, as capital forces banks to internalize the costs of their default, ameliorating the limited liability problem. The authors show that in perfect market, where all the surpluses of the real investments are gained by the borrowers, market pressure ensure that banks will use more capital as an incentive to monitor. When deposit insurance is included in the model, the choice of monitoring can be different: deposit insurance blunts monitoring incentives, thus reducing the likelihood of holding a capital buffer.

Inderst and Mueller (2008) paper introduces a novel argument for why financial intermediaries show a higher leverage than non-financial institutions; leverage improves banks' incentive for investing in new project. The model rests on a functional approach of bank, namely that the function of banks is to make risky loans in a competitive environment in which the borrowers have direct access to real projects, can capture all the rents from it and have an alternative valuable option than asking the funding to banks. Before making the a loan, the bank conducts a credit risk analysis which generates additional valuable information. The loans have a positive NPV if the signal received is higher than a certain level and are therefore undertook. Banks need funding in order to loan and they can collect it trough equity and debt prior to the decision about the loan. The size of investment is taken as given, hence the optimal capital structure decision concerns the ratio between equity and debt to collect. When banks are all equity financed, the optimal credit decision is too conservative because their unique way to protect their capital is to increase the level of signal required; indeed, they cannot use the price of loan arbitrarily if they want to comply with the borrowers' participation constraint. On the contrary, the equity-holders of leveraged banks lose money when they invest in the risk-free asset because they promised a interest rate spread to their investors to compensate for the expected default risk. The wedge between the cost of debt and the risk free rate constitutes a countervailing force to the conservatism of all equity banks. In conclusion, if regulatory constraints for the bank to choose a lower than optimal debt level, its credit decision becomes inefficiently conservative.

1.5 Conclusions

In this paper we review some empirical evidence on banks' capital structure and we try to organize the theory on banking able to explain the facts; there is a general consensus in the empirical literature on the existence of a positive capital buffers and its pro cyclicality. All the authors agree in assessing that market forces, other than regulatory forces, influence the capital structor decision of banks. They disagree, though, on the meaning of market forces, what they are and in which way they work.

We have seen that the general theory about banks' regulation is not able to give insights on how market forces affect banks capital structure. We therefore provided example, between the vast banking literature, of models able to explain what the market forces are and how they work. We have shown that only few papers tackle directly the issue of capital buffers in a regulated environment. More work on the issue needs to be done.

Chapter 2

Capital Requirements and Banks' Leverage

2.1 Introduction

2.1.1 Motivation

This paper intends to study the determinants of leverage for companies subject to a particular regulation based on capital requirements, hence for banks. Studies on banks capital structure proceed together with those on capital requirement: we can not understand the first without knowing why capital requirements have been implemented and which consequence they have on banks' behavior that can affect the leverage decision.

For a full understanding of banks capital structure it is therefore convenient to start with a brief analysis of the history of capital regulation. The seminal papers appeared in the seventies and attempted to define the amount of capital that would be adequate in light of the economic environment and the cost of bank failure (as in Santomero and Watson (1977)). These papers rationalized the imposition of a maximum leverage ratio.

Noticeably absent from that literature was however a detailed consideration of the impact of such regulation on individual bank's behavior and whether the regulation actually achieves its desired goals. The following strand of literature (Kim and Santomero (1988), Gennotte and Pyle (1990), Rochet (1992) and many other contributions) tried to eliminate this ceteris paribus environment; it was soon clear that, with that type of regulation it was possible to arbitrage between assets of different risk, therefore causing a risk shifting attitude of banks towards riskier portfolios for a given size of investment. By investigating the portfolio reaction to capital requirement, they pointed out that the solution to the risk shifting incentives of capital regulation was to adopt a system of capital absorption that reflected the actual risk of the assets in the portfolio. This mechanism is the foundation of the Basel II regulatory framework.

Since the introduction of Basel II, there has been a widespread belief, broken altogether with the 2007-2009 financial crises, that there was no need to investigate banks financing decision since capital regulation constitutes the overriding departure from Modigliani Miller. Since capital is a costly form of financing (actually costlier than insured deposit) all banks should hold as little capital as possible: capital requirement should always be binding and the leverage ratio per se should not represent an interesting decision variable for banks. This reasoning indeed in turn implies that: 1. banks with similar exposure to risk should have similar leverage ratio; 2. fixing asset size (or equity) higher value bank should be more levered than lower value ones; 3. capital buffers of bank should always be zero, i.e. banks should not hold more capital than that prescribed by the regulator.

The break out of the financial crises in 2007 and the many banks defaults that followed has again revamped the attention of academics over the possible drivers of the banks high leverage: those banks were indeed all well capitalized under the risk-related form of regulation while very highly leveraged (as in the cases of Bear Stern and Lehman Brothers). The recent empirical analysis (Gropp, Heider (2008), Mehran and Thakor (2009)) has indeed shown that capital requirement set in the Basel II only have a secondary order effect among the capital structure choice of banks and that, at the same time, the cross sectional variation of banks capital ratio (i.e. the inverse of the leverage ratio) is high and mainly explained by market forces.

This stylized facts contradict the general believes of leverage irrelevance and suggest again a reflection on the determinants of banks capital structure. Possible explanation of banks capital structure can be found in the outdated Modigliani Miller irrelevance proposition (generally not adaptable to the banks environment, as under those assumption banks should not exist at all) or in that corporate finance literature for which capital can reduce corporate value for a variety of factors (namely asymmetric information and moral hazard).

Our paper tries to give a contribution in this direction: we try to determine how banks target a leverage ratio in a contest of asymmetric information. In contradiction with the general corporate finance literature based on signaling, and with the few papers existing on the optimal capital structure of banks in which capital requirements are not necessary binding, we find a negative correlation between leverage and banks quality, which is to say a positive correlation between capital and firm value. At the best of our knowledge, the unique contribution in the literature with the same prediction is that of Mehran and Thakor (2009).

Our main finding is that banks can use their buffer, the capital hold in excess of capital requirement, to signal their true quality to market participants; in the signaling equilibria only the good bank has the correct incentive to signal by targeting a lower leverage ratio; the good banks trades off the benefits from signaling, represented by a lower cost of debt, with its costs, namely the opportunity cost of foregone profitable investment opportunities. The signaling equilibrium exist because the mimicking strategy for the bad bank returns a lower payoff than self-revelation: the bad bank prefers to exploit profits from a bigger investment size instead of from a reduction of its cost of debt. A central role in the equilibrium is played by the probability of default whose speed of decrease is inversely related to banks quality. At the same time capital requirement are binding just for one type of bank, namely the bad one.

2.1.2 Model specification and Main Findings

We present a static model of heterogeneous agents in a context of asymmetric information. There are four classes of agent: two types of banks and two type of managers, a regulator and investors. Managers differ in their ability and, once hired, represent the banks' production technology; at the same time, a complementary part of the banks' production function are intangible assets (the hardware needed to run the software-managers): banks are initially endowed with different levels of the intangible assets. There are four periods: in the first period banks compete to hire a manager; each manager will accept to work for the bank offering the higher compensation (as they are risk neutral agent) given that the wage satisfy his participation constraint. If the bank doesn't hire any manager, then its expected profit is zero. We are therefore assuming that banks can not operate without managers, else that only managers can physically access the investment opportunity set.

When a manager is hired, the bank is considered to be of the same type of the manager himself. Therefore, when a bank hires the high ability worker, it will be named the "good" bank. In the other case, the bank becomes the "bad" bank. The managers' ability is captured by the parameter a_i, that is the upper bound of a uniformly distributed random variable. The ability is increasing in a_i: together with the uniform distribution assumption over random returns on investment, this implies that good managers have a higher expected return on investment.

We assume that all other market participants other than the banks are partially informed and are not able to determine the intrinsic ability of the manager hired by each bank. Bank's type becomes hence private information. Asymmetric information therefore arise as outsiders are not able to detect ex-ante the quality of the bank's manager they are lending their money to. At the same time market participants all share the same prior believes on the distribution of managers' ability (hence on the expected returns they can obtain).

When a bank fails, the negative externality burdened by the society is very high. A regulation is therefore in place as to limit the probability of banks' failure; to achieve this goal, the regulator imposes a risk sensitive constraint of the VaR kind[1]. We are taking the optimal form of regulation as given, while concentrating on its consequences on banks behavior. In the second period the regulator needs to specify the characteristic of capital requirement each bank is subject to.

An important feature of our model is that we do not assume riskless borrowing. In most of the literature capital requirements are rationalized by the existence of a risk-shifting incentive caused by the deposit insurance. While we maintain the limited liability characterization, we are here assuming that the entire debt that banks collect in the market is risky. This is consistent with the fact that banks total leverage is composed primarily of publicly traded debt and REPOs, other than of deposits[2]. The cost of debt, the endogenous probability of default and expected profit on investment are the main driver of banks investment decision.

In the following period, the bank needs to specify its optimal size of investment; choosing the size of the investment is equivalent to determine a leverage ratio (since, by assumption, equity is fixed and investment can grow only with increase in debt). In this context, banks optimization problem is equivalent to maximize the expected utility of final wealth subject to VaR capital requirement and lenders participation constraint. We will highlight the different outcomes assuming perfect and asymmetric information of market participants. In particular, we will focus our attention on the possible strategy designed by the bank in the asymmetric scenario to signal their actual quality to outsiders.

Intuitively, when lenders are not able to discriminate between the two banks, they will tend to apply the same cost of debt for both. The "bad" bank has always got an incentive to lie: this cost of debt is always lower than that the "bad" bank would have to pay when disclosing its true type. On the contrary, the "good" bank is always worse off in a pooling equilibrium in the sense that its profits are lower than under perfect information. Therefore there is space for the good bank to signal its quality

[1] Our model is built upon the Basel II regulatory framework. We will mention later how the Basel III modifications can affect the outcome of our work.

[2] In the model we are assuming agents' risk neutrality and perfect market competition; for these reasons it would not be very interesting to include the opportunity of riskless borrowing to the problem: each bank would indeed optimally choose to finance only at the risk-free rate of return, infinitely. This outcome is neither interesting nor realistic. To add a part of realism to this specification, we would need to assume that deposits are a scarce source of financing and that the market shows some frictions. As an alternative, we consider here the case in which deposits and deposit insurance are fairly priced; the cost of deposits is therefore the same as that of risky borrowings.

by adopting a different investment strategy than the other one.The main achievement of this paper is to show under which condition a separating equilibrium is feasible; separation is possible thanks to signaling and regulation.

2.1.3 Related Literature

This paper relates to two strands of literature. On one side there is the traditional literature on firms' capital structure; the review of Harris and Raviv (1991) is still actual, as there have not been noticeable contributions since then. Of particular relevance for our paper are the studies that focus on the signaling role of debt, as in Ross (1978), Constantinides and Grundy (1989), Heinkel (1982) and many others. In general, all the contribution are consistent in finding a negative correlation between firms' capital and value; better quality firms, therefore, signal their true quality with a higher level of debt, in general because the marginal increase in the probability of failure, due to an increase in leverage, is decreasing in banks' quality.

On the other side,there is a large literature on bank capital, which analyzes its role in regulation (e.g.Barth, Caprio and Levine (2004), Bhattacharya, Boot and Thakor (1998), Dangl and Lehar (2004), Decamps, Rochet and Roger (2004), Hellman, Murdoch and Stiglitz (2001), Morrison and White (2005), and Repullo (2004)) and examines how bank capital affects how banks compete and provide intermediation services (e.g. Berger, Herring and Szego (1995), Boot and Marinc (2008), and Thakor (1996)). But it is only recently that the question of optimal bank capital structure has begun to be addressed (see Diamond and Rajan (2000)). One purpose of this paper is to theoretically examine how banks' leverage targets are determined in the cross-section.

Whithin the corporate finance theory, the most useful models for our purposes are those based on the role of debt as signal that solves the problem caused by asymmetric information. In these models, based on the seminal contribution of Ross (1977) and Myers and Majluf (1984), firm managers or insiders are assumed to possess private information about the characteristic of the firm's return stream or investment opportunity. In this context, capital structure serves as a signal of private information.

Among several contributions, Constantinides and Grundy (1989) propose a model of optimal investment with stock repurchase and financing as signal. Their main goal is to seek modes of financing that result in non-dissipative signaling equilibria, which is to say, a way of financing that allows firms to reach the full information level of investments. They proved that when the investment level is an endogenous variable, the announced level of investment and the announced face value of the issued bond leads to a fully revealing equilibrium. This goal is achieved trough a procedure of stock repurchase that renders costly for the firm to understate their true value. The model predicts also that the higher the private information held by the managers in the first period, the higher will be the debt issue.

Our model differs from previous contribution in several aspects. Most importantly, we introduce limited liability in the managers' payoff function. This modify completely the incentives of managers and renders the profit function always increasing in the level of debt issued. As a consequence, our proposed structure of signaling is in contradiction with the existing theory: the "good" bank is able to send a signal to the market only by issuing lower debt. Our model predicts that debt level and firm quality are negatively correlated.

Recent developments of optimal capital structure of banks have started to prove that capital requirement are not necessarily binding and that capital could be deleterious to bank value. The common presumption is that bank capital imposes a value-relevant cost (e.g. Allen, Carletti and Marquez (2008), Dell'Ariccia and Marquez (2006), Kashyap, Rajan and Stein (2002), Repullo and Suarez (2007), and Thakor (1996)). That is, banks hold capital because of regulatory capital requirements that are motivated by industrywide safety concerns, but these requirements cause value dissipation for individual banks. In fact, this seems to be the standard textbook view of bank capital (see Mishkin (2000)).

Diamond and Rajan (2001) provide another perspective on how bank capital can reduce bank value. They argue that the value of the bank's loan portfolio depends on the bank's willingness to collect repayments from borrowers. So there is a hold-up problem because the bank can threaten its financiers to withhold use of its collection technology, which is unique by assumption. Bank deposits can resolve this hold-up problem because depositors can threaten in turn to withdraw their deposits on demand. Equity capital lacks this feature, so substituting equity for deposits can impede such a resolution. This can result in reduced liquidity creation. Diamond and Rajan (2000) suggest that banks may use capital despite this disadvantage because they face bankruptcy costs with leverage. Taken to the cross-section, their model would imply that banks that face higher bankruptcy costs would keep more capital, create less liquidity and be worth less, implying a negative cross-sectional correlation between bank capital and value.

Apart from this paper, there has been limited theoretical recognition that bank capital may contribute positively to value. Holmstrom and Tirole (1997) develop a model in which capital induces the bank to monitor borrowers and also thereby improves borrowers' access to credit both from banks and the capital market. Allen, Carletti and Marquez (2008) develop a one period model in which a monopoly bank holds capital because it strengthens its monitoring incentive, increases the borrower's success probability and increases the surplus extracted by the bank. When the credit market is competitive, borrowers capture the surplus, so higher bank capital benefits borrowers. The competitive outcome involves banks keeping more capital than they would as monopolists.

The key differences between these papers and ours are as follows. First, the probability of bank defaults is here endogenously determined. Although we make an assumption on the distribution of returns, that are exogenously determined given manager's type, the actual probability of default depends on the actual leverage target of the bank. Moreover, by eliminating the implication of deposit insurance, we concentrate on a risky form of financing for the bank. The actual cost required by investor that lend their money to the institution will have a feedback effect on the probability of default. The banks, in their optimization process, will therefore have to consider the trade-off between increasing the size of investment, hence returns, and paying a higher cos of borrowing. At the same time we include capital requirements as a factor that limits bank's discretion and we find that, just thanks to the existence of this particular regulation, a signaling equilibrium is achievable.

2.2 The Model

2.2.1 Preliminaries

There are four groups of players in our model: two banks, two managers of different quality, investors and a regulator. The role of banks is crucial in the model, as the equilibrium outcome strongly depends on the assumptions made about the structure of the financial system. Banks' essential role, here, is to produce information: thanks to their ability to collect valuable soft information, they can achieve a better investment opportunity set than investors. Since this activity is strongly individual based, human capital is highly valued for banks. They indeed compete to obtain the best human resources available in the market.

Managers' value for the banks' shareholders is connected with their ability to process informations: the higher the manager's ability, the higher is the expected value of returns for shareholders and the higher will be his expected pay. Managers wish to work for a bank if the compensation they receive is sufficiently high; they rather work privately otherwise.

Banks are subject to limited liability. We assume that once they have hired a manager, the manager's incentives are aligned with those of shareholders (i.e.we do not consider any moral hazard aspect, i.e. we assume that managers' actions and effort are contractible).

Banks financial structure is composed by an exogenously assigned level of equity and endogenously chosen debt. Debt is collected from investors. With this assumption we want to capture the fact that while debt is an easily accessible and flexible form of financing for banks, capital can be adjusted only infrequently. The market for debt financing is a perfect market; investors prefer lending money to the bank, in exchange for a returns that capture the banks' risk of default and loss given default, rather than investing directly in risky projects, for which managerial competence is needed.

Finally, the regulator imposes a risk sensitive capital requirement constraint to the banks in order to align their incentives with those socially optimal. Regulator is particularly compelled with the potential negative externality connected with banks' default: the required buffer in terms of capital must therefore be coherent with a certain level of expected social costs of failure. The focus of the paper is to understand how an imposed regulation affects the banks' decision on their leverage target; what we did not find is a socially optimal form of capital requirement. Every comment on the equilibrium efficiency is therefore avoided from our paper.

2.2.2 Model Details

Preferences and time line

There is universal risk neutrality; the gross risk-free interest rate normalized to zero. We have four dates, $t = 0, 1, 2$ and 3.

At t=0 banks compete to hire one of the two managers. They set a wage offer $\{w_i, w_j\}$ for each manager they want to hire; the manager can either accept or reject the banks' offer. When managers reject, banks make zero profit and they are not able to invest in risky projects. Banks and managers make their choice simultaneously.

A bank type is then determined by the quality of the manager hired.

In the next period the regulator imposes an appropriate capital requirement in the form of a VaR constraint, based on its believes over banks' type.

In period 2, banks decide their optimal investment strategy and simultaneously collect debt in the market as to maximize the expected value of final wealth conditional on non default (as they are subject to limited liability). Finally, in period 3 uncertainty is resolved and returns are realized.

Managers investment opportunity set

There are two managers that the banks can hire. Managers differ with respect to their intrinsic ability. To simplify things, we assume that the "good" manager is able to invest in an asset whose expected return is higher than that of the "bad" one.

Hence the manager's ability implies the possibility to access to different investment opportunity sets: the expected return on investment are an increasing function of the manager's ability.

We moreover assume the distribution of returns of the risky investment follows a uniform distribution:

$$\tilde{r}_i \backsim U[-1; a_i]$$

$\forall i \in \{B; G\}$. The upper bound of the distribution, a_i, is the parameter that captures the managers' intrinsic ability: it is actually an increasing function of the ability. Recall that we assume in the model only two managers' type, a good and a bad type, we have that $a_G \geq a_B \geq 1$

Returns on investment are therefore ranked by first order stochastic dominance: $\forall x \in \{0, a_B\} : \Pr_B(x \leq z) \geq \Pr_G(x \leq z)$. Moreover, since this are returns obtained by the managers, and since managers can be seen as the production technology of the banks, we are assuming a constant return to scale production technology for banks: this is going to be a fundamental assumption in our model as it drives the relation between expected profits and leverage as by increasing the size of the investment, the expected return per unit is constant.

Managers will accept the banks' remuneration offer if higher than their outside options; we assume they can indeed decide to carry on the investment activity privately (i.e. they can start a fund). At the same time, they would need to incur in some fixed costs necessary to acquire the "infrastructure". Only by having an "infrastructure", it is possible to access funding from investors.

To simplify further, we normalize the "bad" manager's outside options to zero.

Banks

Banks are financial intermediaries that invest the money collected in risky projects (real or financial projects); intermediation is justified by the higher ability of banks to generate valuable information over the risky projects that in turn affects their risk-return profile.

There are two different bank in the model, $j, \in \{1, 2\}$. Each bank is exogenously endowed with the same level of capital, e_0; they do not have further access to the equity market. Our model focuses on short period analysis, hence it is plausible to assume that banks are not able to issue equity frequently.

The two banks are different with respect to the costs they need to burden when hiring a manager. A manager needs an intangible structure to work with; moreover, the higher his ability, the more sophisticated the tools he needs to have, hence the higher is the investment in intangibles that banks must accomplish[3]. We assume that bank 1 is endowed with a better intangible technology: it does not need any further investment when hiring the good manager. The other bank, 2, needs to improve its technology instead when hiring G. This fixed (sunk) cost is quantified in F. Neither bank need an improved technology when hiring the bad manager: the fixed cost of hiring the bad manager is zero for both banks.

There are two set of actions banks have to take: in the first period they have to fix a wage schedule for each manager in order to hier one, the other or neither of them. In the next period they will have to decide how much they are willing to invest, given the capital requirement and lenders participation constraints.

At $t = 0$ the two banks are "competing" for the two managers in a simultaneous game; their net profits is decreasing in wages, hence they always wish to offer a low wage. At the same time, thought, they must consider the other player's incentive when fixing a too low wage: the opponent could indeed offer a slightly higher wage, hire the good resource and still make a positive extra profit. This is a simple game similar to the Bertrand competition game where agents (banks) are heterogeneous in their cost functions. We will concentrate on the pure strategy Nash equilibria.

When the agent is hired, the bank must disclose its type to the regulator. In a contest of asymmetric information, the low type bank has always the incentive to lie about its true nature: the good bank pays lower charges over its borrowing and is allowed to expand the size of its investment and leverage to an higher extent; since profits are a positive function of the size of investment, good bank's expected profits are higher.

When the investor and the regulator are not able to detect the banks' quality directly, they are not able to update their ex-ante believes, which are based on the sample frequencies, assumed as follows:

$$\Pr\left(Bank_i = G\right) = 1/2$$
$$\Pr\left(bank_i = B\right) = 1/2$$

Each bank has the same ex-ante probability of being the good one.

[3]One may argue that the assumption that good managers need more investment in intangible to work looks questionable. It could be argued that successful managers be good at running their own show, hence require less "hardware". We prefer to stick to our assumption as we see the hardware and the software two complementary factors in the production function: a good managers can not be as good if not provided with the right tools.

Asymmetric information makes the choice of leverage a plausible way of true signaling: the good bank can try to signal itself trough the amount of debt collected in the market. As is would be detailed later, only the "good" bank has an incentive of reducing the amount of investment from that allowed by the regulator to signal to market participants its true type, hence paying a lower interest on the debt collected. In the second part of this paper we will concentrate on studying the separating equilibria generated by signaling.

In period 2, the banks have to decide the optimal investment strategy. This decision is be based upon the marginal benefits and marginal cost of expanding the size of investment. In the optimization process each bank must consider the limit imposed by the regulator trough the capital requirement and the lenders' partecipation constraint.

We represent the balance sheet structure of each bank in the following equation:

$$\begin{aligned} x_i &= D_i + e_0 \\ x_i(1+\tilde{r}_i) &= D_i(1+r_{i,d}) + \tilde{e}_{1,i} \end{aligned}$$

where $\forall i \in \{G, B\}, (1 + r_{i,d})$ represents the gross cost of debt financing, $(1 + \tilde{r}_i)$ the random return on investment for each bank i and x_i is the size of investment in the risky asset. The initial endowment of capital is e_0, equal for both bank, while the random value of final equity is represented by $\tilde{e}_{1,i}$. At the same time D_i is the amount of debt collected by each bank, needed to pursue the chosen size of investment. The first equation shows the bank budget constraint at the initial period, while the second is the budget constraint at the final realization of returns. Those budget constraints are directly derived by the banks' balance sheets, for which total assets must equal total liability in each period.

By expressing the amount borrowed in period one as a function of the size of investment and initial equity and substituting it in the second equation, we obtain an expression for the final value of equity (the final wealth) that depends only on the endogenous decision of the size of investment:

$$\tilde{e}_{1,i} = x_i(\tilde{r}_i - r_{i,d}) + e_0(1 + r_{i,d}) \tag{2.1}$$

From the equation (2.1) we can characterize the probability of default; defaults is realized whenever, at the realization of returns, the value of assets are insufficient to repay the initial debt and the interests matured on top of it. In this scenario, the final value of equity is lower than zero. The probability of default (PD) is therefore defined as the probability of $\tilde{e}_{1,i}$ being lower or equal to zero:

$$\begin{aligned} PD_i &= \Pr\left(\tilde{e}_{1,i} \leq 0\right) \\ &= \Pr\left(x_i(\tilde{r}_i - r_{i,d}) + e_0(1 + r_{i,d}) \leq 0\right) \\ &= \Pr(\tilde{r}_i \leq r_{i,d} - \frac{e_0\left(1 + r_{i,d}\right)}{(x_i)}) \end{aligned}$$

The probability of default is therefore endogenously determined, positively correlated with the size of the investment (as the capital buffer is lower for higher sizes of investment) and with the cost of borrowings (higher costs reduce the area for which returns are sufficiently high to cover the costs themselves). When the realized returns are lower than $r_{i,d} - \frac{e_0(1+r_{i,d})}{(x_i)}$, the bank defaults.

Finally, due to limited liability, banks are only willing to maximize their expected profit conditional on the non defaulting event, as when defaulting banks are not subject to any sanction. The profit function can be expressed in the following way:

$$\begin{aligned} E\left(\tilde{\Pi}_i \middle| non - failure\right) &= \int_{r_{i,d} - \frac{e_0(1+r_{i,d})}{x_{r,i}}}^{a_i} \tilde{e_{1,i}} \mathrm{d}r \\ &= (1 - PD_i) E\left(\tilde{e}_{1,i} | \tilde{e}_{1,i} > 0\right) \end{aligned} \quad (2.2)$$

Investors

We assume that there exist a wholesale market for funding, where banks can collect their preferred amount of borrowings, given the investors' participation constraint. Financiers are indeed intended to lend their money if and only if the expected return on the investment, accounting for the probability and loss given default, is equal to one (as we assumed the market for borrowing to be perfectly competitive). This condition determines the banks cost of funding as the minimum rate the bank needs to pay to debt holders. Bank cost of funding, $r_{i,d}$ is a function of the level of debt issued (hence on the size of investment).

The Financiers' payoffs are dicotomic: they will get $D_i(1+r_{i,d})$ when the bank does not default at time 3 and $x_i(\tilde{r,} i + 1)$ (the residual value of the asset) in the opposite scenario. In this context, the loss given default, the complementary of the recovery rate, follows the same distribution of r_i: $LGD_i \backsim U[-1; r_{i,d} - \frac{e_0(1+r_{i,d})}{(x_i)}]$ Altogether, we rewrite the Financiers participation constraint as follows:

$$D_i = D_i(1 + r_{i,d})(1 - PD_i) + (PD_i) x_{r,i} E[(1 + \tilde{r}_i) | e_1 \leq 0] \quad (2.3)$$

The financiers expect to earn a unitary return of $(1+r_{i,d})$ when bank i does not default and to recover $1 + \frac{1}{2}(r_{i,d} - \frac{e_0(1+r_{i,d})}{(x_i)} - 1)$, the expected value of the recovery rate, in the case of default.

Regulator

Regulation is needed in our model due to social costs of failure. Banks' default can in fact produce a considerable amount of negative externalities, such as contagion, disruption of the payment system and contraction of real output; due to limited liability, banks are not self-incentivized to consider those externalities in their profit maximization: regulation is set to align agents' incentives.

We take the actual mechanism designed to limit the probability of default as given: we consider indeed the impact of a risk sensitive capital requirement on banks' investment decision. The risk sensitive requirement takes the form of a value at risk (VaR) constraint on the portfolio exposure, as outlined by the Basel II regulatory framework. The VaR is a measure of the risk actually taken by the banks trough their investment strategy; it represents indeed the quintile of the portfolio returns such that the probability of negative returns below that threshold equals to β_i. Since the returns on portfolio for a given manager type are related only to the size of the investments, x_i, the VaR effectively imposes a risk-related restriction on banks' leverage[4].

The capital requirement can therefore be described by the following equations:

$$VaR_i \leq e_0$$

and the VaR_i is defined as:

$$\Pr(x_i \tilde{r}_i \leq -VaR_i) = \beta$$

The regulation generates therefore a biunivocal relation between the parameters that define the VaR_i and the size of investment. The regulator choice consists in defining the appropriate value of β for each bank.

The paper does not focus on the efficiency of regulation; for that sort there would be the need to define properly social costs and benefits from regulation. The social costs can be related to a sub-optimal investment choice of banks; in this paper we will indeed prove that in a signaling equilibrium the good bank invests less than it would be the case in a full information setting. In this sense, the regulation causes a credit crunch. On the other side, the social benefits of regulation are related to a lower social cost of failure thanks to a bound in the probability of default.

[4]In our setup the investment choice concerns the size of the investment and not directly the portfolio allocation; this is so because we assumed that the portfolio returns are related to the manager's ability and not to the return to the assets; managers in turn invest in the assets and their ability has an impact on their portfolio composition. We therefore consider the portfolio allocation issue only indirectly: by hiring one type of manager the bank is indirectly choosing an optimal portfolio allocation. This fact has an important impact on the consequences of the risk related capital requirement: for a given manager type, that translates into a leverage ratio restriction in which higher leverage is associated with higher manager's ability.

As this paper is written, major revisions to the current Basel II framework have been proposed. The new framework, that will be named Basel III, incorporates two fundamental modification to the regulatory framework: on one side it introduces a risk-unrelated leverage ratio, on the other a brand new liquidity constraint. The leverage ratio should serve as a backstop to risk-weighted capital measures and to contain the build up of excessive leverage in the financial system; this ratio will ameliorate the pro-cyclical effects of Basel II. In times of prolonged economic growth the measured risk of assets, that feeds the capital requirement formulas, tend to decrease; as a consequence the capital requirement are less binding at the top of the cycle, leaving banks over-leveraged in the transition from an economic up-turn to a down-turn. The simple leverage ratio, should therefore be beneficial in limiting the pro-cyclicality effects of regulation by limiting the leverage build up banks tend to have in periods of economic booms. The liquidity standard are set to make banks more resilient to potential short-term disruptions in access to funding and to address longer-term structural maturity mismatches in their balance sheet.

The new liquidity constraint is very difficult to add in our model: our framework based on perfect market is inadequate to explain any liquidity friction. For its introduction we should modify the basic assumption that banks are price takers and specify differently the demand and supply of assets and funding; this modifications, although very interesting, go beyond the current goal of the paper, which is that to challenge the relevance of leverage targeting as a signaling device. On the other side, the introduction of the simple leverage ratio can be added to our model as an additional constraint in the optimization program; this requirement could impact on the separating equilibria found in this paper[5]. We will focus on this issue in the next steps of our work.

2.3 Initial Analysis: Some Basic Results

We solve the model using backward induction. We first analyze the banks' optimal investment decision, subject to capital requirement, in period 2. Subsequently, we compute optimal regulation in period one and the optimal hiring process of the initial

[5]The effects of the leverage ratio restriction depend on the level at which that is fixed: if it does not bind any bank (i.e. it is higher than the risk-related leverage ratio), then it is redundant; this case would not be particularly interest to study. In another scenario, the ratio could bind only the better quality bank investment choice (as the risk-related ratio allows the better quality bank to be more leveraged). In this context the separating equilibrium would still hold as for the equilibrium the optimal strategies are related only to the level of leverage achievable to the lower quality bank and are independent from the size of investment achievable from the better quality bank under full information. Different is the case of a leverage ratio being binding for both the good and bad bank: in this case we would need to re-dirive the banks optimal strategies and check whether a separating equilibrium is still feasible.

period, anticipating the future events. We will proceed by describing separately the model solutions under perfect information (that will serve as benchmark case of comparison) and under asymmetric information (i.e. when the regulator and the investors are not able to observe banks' type directly).

2.3.1 Banks optimal Investment decision under PI

When information is symmetric among all agents, banks' type is clearly discernible. As a consequence, financiers are able to correctly price the appropriate cost of funding for each bank; since the "bad" bank distribution of returns determines an higher probability of default for a given size of investment [6], investor will charge it a higher cost of funding.

Under perfect information the bad bank is not able to disguise the market about its intrinsic true quality, hence the regulator is able to fix an enforceable capital requirement.

The decision over the optimal size of investment is the solution to this simple maximization problem:

$$\begin{gathered}\max_{x_i}\{(1-PD_i)E(\tilde{e}_{1,i}|\tilde{e}_{1,i}>0)\}\\ s.t.\quad D_i = D_i(1+r_{i,d})(1-PD_i)+(PD_i)x_{r,i}E[(1+\tilde{r}^i)|e_1]\leq 0\\ VaR_i\leq e_0\end{gathered}$$

We have noticed before that the lender participation constraint is composed by two elements: the first is the rate of return on funds given that the realization of returns will be positive for the bank; the second is the expected recovery rate given default. The rate of return necessary to satisfy the lenders' participation constraint must therefore compensate for the lender's expected loss in case of default. From the lenders participation constraint we can recover the appropriate cost of debt financing, $r_{d,i}$, by solving the following second order equation:

$$r_{d,i}^2\left(\frac{e_0-x_{r,i}}{2}\right)+r_{d,i}(a_ix_i+e_0)+\frac{e_0-x_i}{2}=0$$

There are two possible solutions for the equation; given our initial assumption[7], the

[6] From the assumption of returns being uniformally distributed, the probability of returns being lower than a certain level, say y, is inversely relate to the length of the distribution interval. Since $a_G > a_B$, then the area under the curve between $(-1, y)$ is going to be higher for the G distribution, as $\frac{1}{1+a_G} < \frac{1}{1+a_B}$

[7] From our definition of PD_i, and from the fact that $0 < PD_i < 1$, we recover two ulterior conditions $r_{d,i}$ must satisfy, namely: $\frac{e_0-x_i}{x_i(1-e_0)} < r_{d,i} < \frac{a_ix_i+e_0}{x_i-e_0}$

uniquely acceptable solution for it is:

$$r_{d,i} = \frac{-(a_i x_i - e_0) + \sqrt{x_i^2(a_i^2 - 1) + 2e_0 x_i(a_i + 1)}}{e_0 - x_i} \tag{2.4}$$

The cost of debt financing is therefore an implicit function of the banks' investment choice x_i. In particular, it is an increasing and concave function of it. Intuitively, the higher the banks leverage, the higher will be the probability of default (as the equity buffer decreases in the bank's size); this effect is particularly strong for low levels of leverage where the amount of equity can sufficiently contrast most of the negative outcomes of returns, so that default can be avoided in most occasions, while it smoothly becomes ineffective when the size of the portfolio grows (i.e. when x_i is very high, equity can only offset returns that are just marginally negative). Put it in another way, the marginal contribution of equity protection (the marginal effect of the buffer) is decreasing in the size of leverage. Finally, as $x_i \to \infty$, $r_{d,i} \to a_i - \sqrt{a_i^2 - 1}$ and the payoff structure of financiers are the same as those of equity-holder without the limited liability option.

Another way to explain the concavity of the cost of debt function is that of looking at the impact of an increase in the size of investment on the expected recovery given default. The expected recovery is given by the product between the probability of default, the exposure at default and the expected return given default ($ER_i = PD_i * x_i * E[(1 + \tilde{r_i})|\tilde{e_{1,i}} \leq 0]$). The expected recovery is an increasing function of the size of investment; an increase in asset size increases the probability of default (for a lower protection offered by the buffer); at the same time it increases the exposure at the default. It can be easily shown that the positive effect on the exposure at default is stronger than that on the probability of default. Overall, speed of the compensation required by investors for the chances of not receiving back their funds decreases in the size of investment for the positive effect that the size of investment has on the expected recovery at default.

We have reproduced in Figure 1 the graph of the cost of debt financing as function of the size of investments, for $e_0 = 1$, $a_i = 2$. The graph clearly shows the concavity and asymptotic behavior of $r_{d,i}$. Finally, taking the size of investment constant for both banks, the market will always apply a higher cost of debt to the "bad" bank (i.e. $r_{d,i}$ is a decreasing function of a_i).

We can now substitute the explicit solution for $r_{d,i}$ into the expression of the prob-

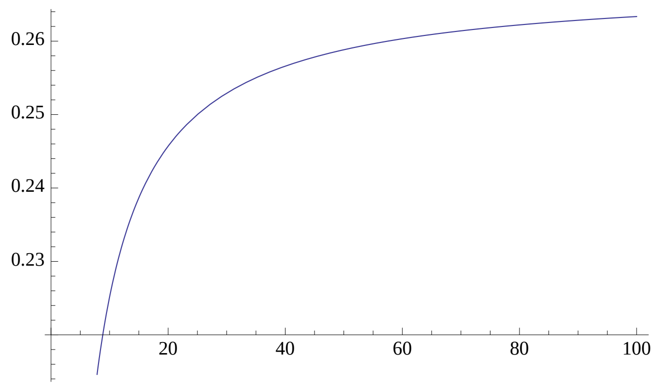

Figure 2.1: cost of debt financing

ability of default, to obtain:

$$PD_i = \frac{(1 + r_{d,i})(x_i - e_0)}{x_i(a_i + 1)} \tag{2.5}$$

$$= \frac{x_i(a_i + 1) - 2e_0 - \sqrt{x_i^2(a_i^2 - 1) + 2e_0 x_i(a_i + 1)}}{x_i(a_i + 1)} \tag{2.6}$$

As before, the probability of default is an increasing and concave function of the size of investment. The function is steeper then that of the cost of debt: changes in the size of investment imply proportionally bigger changes in the probability of default than in the cost of debt, because of the semilinear payoff structure of debt and the positive effect of the size on the expected recovery rate. As before, the probability is negative related to the value of a_i; finally, the probability of default decreases more than proportionally than the cost of debt for increasing values of a_i.

By combining the previous two equation for the cost of debt and the probability of default, we obtain the following simplified version of expected profits:

$$\Pi_i = (1 - PD_i(r_{d,i}(x_i)))E(x_i(\tilde{r}_i - r_{d,i}(x_i)) + e_0(1 + r_{d,i}(x_i))|e_1 > 0)$$
$$= e_0 + \frac{x_i(a_i - 1)}{2}$$

Hence the profit function is linearly increasing in x_i; the higher revenues that derives form an increase in the investment size outweigh the higher cost of debt and probability of default. This is due to the fact that revenues are linear in x_i (as banks are risk neutral), while both the cost of debt and the probability of default are concave function of it; when the leverage is high, the shareholders expected gains from a marginal increase in the size of investments is higher than for lower levels of leverage.

This is the well established risk-shifting effect of limited liability; in our model the effect could be renamed "leverage shifting" as in an unconstrained world with constant return to scale production functions, the banks would always like to expand the size of their investment toward infinity.

All this said, it is obvious that capital requirement, that limit the amount of x_i the bank can undertake, are always binding.

Lemma 1. *In a context of perfect information, each bank will choose to invest as much as possible; the optimal choice on asset size and leverage is therefore determined by a binding capital requirement:*

$$x_i = \frac{e_0}{1 - \beta(a_i + 1)}$$

The expected payoff is:

$$\frac{e_0(a_i + 1)(1 - 2\beta i)}{2(1 - \beta(a_i + 1))}$$

and the expected probability of default is:

$$1 - \sqrt{1 - 2\beta}$$

It is worth noticing here that for the same level of β:

- The size of investment and the leverage ratio are an increasing function of a_i, hence the "good" bank is allowed to invest more;
- The banks' expected profits (Π_i) are an increasing function of a_i; this generates an incentive for "bad" bank to lie about its true type when information is asymmetric between market players.

2.3.2 Manager hiring decision

We come now to analyze the banks' hiring decision. So far, we have focused on the analysis of the banks' investment choice assuming that one bank had hired the "good" manager and the other the "bad" one. We must check therefore under what condition this assumption is satisfied. More precisely, we need to detail what compensation skeme is consistent with such an outcome.

The hiring process of period zero is described as a simultaneous game in which both banks submit their offer and the managers can decide which offer to accept, if any.

The "good" and "bad" manager differ in their intrinsic ability of generating expected returns. In particular, the first, when hired by a bank, can promise higher expected profits than the latter. The information between the managers and shareholders is perfect by assumption, so that each bank knows with probability one its expected profits once a manager is hired. We also do not consider any moral hazard issue, assuming that all managers actions and effort are contractible.

Managers are risk neutral agent. The different ability implies different reservation utilities: it is fair to assume that the agent with higher ability has also higher outside options when not hired by a bank.[8] At the same time, the "good" manager will accept the job only if the wage is representative of their true ability; they are therefore not willing to accept when the wage they are offered is lower than that of low ability managers. We recall $w_{j,i}$ the wage offered by bank j to the manager i. Putting together the previous two conditions, we have that $w_{j,G} \geq \max\{\bar{u}, w_{j,B}\}$, where we used $\bar{u}$ to indicate the "good" manager's reservation utility. To simplify the exposition of the problem, we assume that "bad" managers have no outside option: they will therefore be willing to accept any wage offer higher than zero.

The "Good" manager reservation utility is positive and equal to $\bar{u}$. This is the profits he would obtain employing his human capital in alternative activities, such as starting a private business. Of course, the higher his reservation utility, the higher the wage offer needs to be if a firm is willing to hire him.

Both banks are fully aware of the consequence of hiring one manager or the other; their ability is common knowledge and so are Π_G, the expected profits of the high type, and Π_B, the expected profits of the low type. If both firms have the same hiring cost function, then a Bertrand Nash equilibria is reached. In this rather unusual case, both banks realize zero profits in equilibrium, no matter which manager they hire, while each manager extract all the surplus generated from the investment; the wage schedule is identical to the expected bank profits: $\{w_G, w_B\} = \{\Pi_G, \Pi_B\}$.

Although it is possible that both banks share the same hiring costs, this is a rather unusual case. The hiring cost are the sum of all the fixed cost firms incur between the date they posted the vacancy and that in which the managers can physically start to work; this includes all the direct cost of the selection process (screening, interviewing...) and also all the indirect cost the firm needs to undertake as to enable the manager to effectively do his job: investment in infrastructure, computer, software, licenses and also in the human resources as well. Since firms are typically different in their technological endowment, we will fairly assume they will have different hiring cost.

[8]Given the wages offered to bank's managers, it looks like the competition over good manager in the financial sector is fiery. At least so far: shareholders should update their beliefs about the actual ability of managers.

More precisely, we are here assuming that bank 1 is better endowed than bank 2; hiring the "good" manager can be more expensive for the enterprises; that is because, in order to exploit his ability, the "good" needs an advanced surrounding environment (in terms of other staff member and technology used). Since bank 1 starts off with a higher endowment of intangibles, it will be less expensive for it to hire the "good" manager: its internal structure is already adequate for him to operate well. This is not the case, indeed, of bank 2, whose additional investments needed when hiring the "good" manager are positive and equal to F.

Once again, we think about the assumption about the heterogeneity in hiring costs is a sound one. We indeed retain that a "good" manager is so defined not only because of its intrinsic ability, but also because he can work in an organized environment. Just to make an example, let's think about a trader in Goldman Sachs; he is considered as a high ability worker able whom produces high expected returns for the firm. This person will not be able to reach the same profit level if employed in a small retail bank as all the support he was receiving at Goldman, the flow of information, the technological platform and so on wouldn't be the same. Therefore, if the small retail banks want to hire the "good" manager and leave invariant his productivity, it will need to invest in intangibles as well.

This said, let's define $\Pi_{j,i}$ the expected profit of bank $j \in \{1,2\}$ when hiring manager $i \in \{G,B\}$, net of the hiring costs. Given the discussion of the previous section, the bank 1 possible payoffs are:

- Firm 1 offers $(w_{1,G}; w_{1,B})$ and G accepts the offer:

$$\Pi_{1,G} = \frac{e_0(a_G+1)(1-2\beta)}{2(1-\beta(a_G+1))} - w_{1,G}$$

- Firm 1 offers $(w_{1,G}; w_{1,B})$ and B accepts the offer:

$$\Pi_{1,B} = \frac{e_0(a_B+1)(1-2\beta)}{2(1-\beta(a_B+1))} - w_{1,B}$$

- Firm 1 offers $(w_{1,G}; w_{1,B})$ and G and B both don't accept:

$$\Pi_1 = 0$$

Bank's 2 payoffs when hiring the "bad" manager or hiring none of them are the same as for the other bank, hence:

$$\Pi_{2,B} = \frac{e_0(a_B+1)(1-2\beta)}{2(1-\beta(a_B+1))} - w_{2,B}$$

and

$$\Pi_2 = 0$$

. The payoff when manager G accepts is although different:

$$\Pi_{2,G} = \frac{e_0(a_G + 1)(1 - 2\beta)}{2(1 - \beta(a_G + 1))} - w_{2,G} - F$$

Proposition 1. *When the expected profits of the bank hiring the "good" bank are sufficiently high, such that $w_G \geq \bar{u}$,there is a pure strategy Nash equilibrium for this game in which bank 1 offers $\{w_{1,G}, 0\}$ and G accepts the offer; similarly bank 2 offers $\{0, w_{2,B}\}$ and B accepts. The equilibrium pays are:*

$$w_{1,G} = \Pi_G - 3/2F = \frac{(a_G + 1)[e_0 + \beta(3F - 2e_0)] - 3F}{2[1 - \beta(a_G + 1)]}$$
$$w_{2,B} = \Pi_B - 1/2F = \frac{(a_B + 1)[e_0 + \beta(F - 2e_0)] - F}{2[1 - \beta(a_B + 1)]}$$

In equilibrium, the expected profits of bank 1 are higher than those for bank 2, respectively equal to $3/2F$ and $1/2F$.

The compensation scheme offered by shareholders to the managers are a linear transformation of the banks' profits; the kind of contract that can implement this scheme, is very easy: the contract would provide only a performance compensation to the manager equal to the full amount of the profits made less a fixed amount that represents a fraction of the fixed costs. Managers and shareholders are therefore aligned in their intent of maximizing the banks' terminal value of equity; at the same time, the managers are also affected by the limited liability bias as they do not receive any punishment in the case of bank's default.

Proof. To begin with the proof, note that both banks setting their wage schedule as in proposition 1 is indeed a Nash equilibrium. At these wage rates, each firm earns a fraction of bank 2 fixed costs, respectively equal to 3/2 for bank 1 and 1/2 for the other. Neither bank can gain by reducing the wage offer as, by so doing, the manager would accept the opponent's offer; by increasing the wage offer, the bank would still hire the same manager but reducing its own profits. So now we only need to show that this equilibrium is unique. Suppose, first, that the higher of the two wages offered for the "good" manager is higher than $\pi_G - 3/2F$. The firm naming this price incurs lower profits. But by reducing its price until $\pi_G - 3/2F$ it increases its profits while still winning the competition. Now suppose that bank 1fixes a wage lower than the equilibrium level and precisely equal to $\pi_G - 3/2F - \epsilon$; by so doing bank one would increase the profits by ϵ. The other bank has now a profitable opportunity to higher the "good" manager, by fixing an higher wage, equal to $\pi_G - 3/2F - \epsilon/2$. Bank 1 in this scenario makes zero profits, while the other earns: $(F + \epsilon)/2$. Thus, these wage choices are not an equilibrium. The same reasoning apply to the "bad" manager's wage offer. □

2.4 Asymmetric Information and Signalling

In the previous section we have studied the banks' optimal behavior assuming that all the agents were sharing the same informations. In this set up we concluded that in equilibrium bank 1 hires the good manager and bank 2 the bad one; the good manager receives a wage higher than his reservation utility and therefore accepts the offer. His wage is moreover equal to the expected bank's profit conditional on the non default event (managers have the same limited liability option as shareholders) net of half the hiring cost, and therefore higher than his opponent's one.

Next we have studied the banks' optimal investment allocation of period 2; banks are subject to limited liability and have an incentive to expand infinitely their leverage. Capital requirement, that are set by the regulator to limit the banks' probability of default to avoid the negative externality of a bank failure and that take the form of a VaR constraint, turns out to be always binding. In equilibrium, the value at risk constraint behave exactly in the same way as a risk-related leverage ratio, allowing the good bank to gain in higher leverage. Also, in equilibrium the probability of default of the two types of banks are equalized, and equal to a function of the parameter β chosen by the regulator in fixing the capital requirements. Investors apply a lower interest rate on borrowings to the "good" bank, whose leverage is higher; this is because, while the probability of defaults are the same, lenders to the good bank expect an higher recovery rate from the investment given default. Finally, shareholders of G expect to receive an higher gross profit than those of B.

When asymmetric information arises, bank's type becomes private information. Both the investors and the regulator don't know which bank is actually the good one but they share the same believes about the true distribution of returns for each bank; they also know the total share of "good" and "bad" present in the market.

The "bad" bank has a high incentive to lie about its own identity pretending to be the opponent's type. Unless the "good" bank has an incentive to signal itself as being the "good" one, a pooling equilibria will arise, where both banks undertake the same investment strategy and investors will charge an average cost for borrowing.

Signalling is always a costly action; in our model the "good" bank can signal itself by choosing a lower leverage than that allowed. Investors, indeed, believe that only the "good" bank has the incentive to reduce the leverage; the "good" bank will decide to signal itself only if the benefits in terms of lower interest rate applied to borrowings are higher than the reduction of profits generated by a lower leverage[9].

In the paragraphs that follow, we will first analyze the period 2 equilibrium absent capital requirement. We will then introduce the VaR constraint and see how this contribute in generating information for market partecipants.

2.4.1 Unconstrained leverage decision under asymmetric information

Under asymmetric information banks type, a_i, is private knowledge: only the banks themselves know their true type. We assume that everything else in the game is publicly known (i.e. investors ex-ante believes, payoff functions, one bank's belief of the opponent's type...).

A strategy of this game, $x_i(a_i)$, is the choice of targeted leverage each bank chooses. There are two possible outcome of the game: a pooling equilibria, where both banks play same strategy and a separating one.

We follow the traditional strand of literature on signalling in assuming that banks form a population of finite dimension, normalized to N. We moreover assume that the fraction of "good" bank over the entire population is $(P/N) = p = 1/2$; the "bad" fraction is therefore equal to $(N - P)/N = (1 - p) = 1/2$.

For N large enough, the ex-ante unconditional believes about the probability of each bank to be of a particular type is equal to the frequency of the type over the entire population. We therefore have that:

$$\Pr(Bank_i = G) = 1/2$$
$$\Pr(Bank_j = B) = 1/2$$

A pooling equilibria can arise when investors believe that, for a given strategy $\widehat{x_p}$, the ex-post probability are the same as the ex-ante ones. In a pooling equilibria, given it exists, these believes are not updated.

We also make a simplifying assumption about the out of equilibrium believes of investor: they assume, indeed, that whoever deviates from the equilibrium is the "bad"

[9] In this respect, the signalling game resemble that of a monopolist that weights off costs and benefits of reducing the good price

agent:

$$\Pr(Bank_i = B | x_i \neq \widehat{x_p}) = 1$$

On the contrary, in a separating equilibria investors believe that, given the agents optimal strategies, they can distinguish between the "good" and "bad" bank with probability one. When the chosen leverage ratio is different, investors believe the bank with the lower ratio is the "good" one[10]. We will show later that this believes are coherent with updating Baysian's expectations[11]. When banks' strategy differs, investor know with certainty bank's type:

$$\begin{aligned} \Pr(Bank_i = G | \widehat{x}_G) = 1 \\ \Pr(Bank_j = B | \widehat{x}_B) = 1 \end{aligned}$$

Once again, investors punish any deviation from the equilibrium strategy: they will retain any agent deviating from the equilibria to be the "bad" agent.

As mentioned before, the regulator shares the same believes about the banks type with investors. It will therefore punish any deviation from equilibria by reducing the leverage the bank can undertake.

On the existence of a separating equilibrium

Proving the existence of a separating equilibrium is somehow controversial. We need to show that, given the agents believes in a separating equilibrium, each agent chooses the optimal strategy and nobody has an incentive to deviate.

In particular there are four conditions that need to hold simultaneously:

- The expected utility of the "good" bank by choosing $\widehat{x}_G$ must be higher than its reservation utility; this should in turn be higher than the profits when the bank decides not to participate in the game (i.e. does not borrow anything from investors) therefore higher than the expected returns when investing only its initial endowment;

[10] This aspect of the model is in contrast with previous literature, such as Ross (1977); in that model, indeed, the good bank signal by using higher leverage ratio. The divergence is due to different incentive that we introduced in the profit function: we focus our attention to positive NPV projects and taking into account the limited liability bias. Both this factor render both banks profit functions increasing in leverage. Hence, for the signal to be incentive compatible, the good bank's leverage must be lower than the other.

[11] We will prove indeed that only the good bank has an incentive to reduce the leverage ratio.

- The expected utility of the "bad" agent when choosing $\widehat{x}_B$ must also satisfy the reservation utility constraint determined in the same way as before;
- The "good" bank expected utility from deviating and choosing $\widehat{x}_B$ should be lower than the expected utility from non deviating;
- The "bad" bank should not have an incentive to deviate form $\widehat{x}_B$ by choosing $\widehat{x}_G$ and pretending to be the good agent.

The first two of this conditions are the agents participation constraint; the latter are instead the incentive constraint or no mimicking conditions.

We will now verify the existence of a separating equilibria under two different regimes: with and without the capital requirement constraint. When the regulator enforces the VaR limits on bank's investment, we need to take into account two additional constraints:

- $\widehat{x}_G$ must be lower or equal to the limit imposed by the regulator for the "good" bank;
- $\widehat{x}_B$ must be lower or equal to the limit imposed by the regulator for the "bad" bank.

Since we are studying a self-revealing equilibrium, we can concentrate our attention to the capital requirement imposed to the "bad" bank. This is because a capital requirement over investment has the same effect of a leverage ratio restriction. Therefore, since the only way to produce the signal for the "good" bank is to limit its leverage, the imposed capital requirement will only be binding for the "bad" bank. We will then only need to specify the regulation applied to the "bad" bank.

Separating equilibria without capital requirements

For the moment, we forget about the regulator: we want to see whether in an unconstrained world there is a possibility for the signalling equilibrium to arise. Intuitively, the "good" bank has an incentive to signal when the cost of funding applied on its borrowings is "too high": in this case, it can be appropriate for the "good" bank to reduce the level of investments and borrowings to be recognized as of its true type. On the contrary, the "bad" bank incentive to deviate is stronger the more the investor would punish him when knowing its true type. Since we assumed that the investment opportunity set is characterized by assets with positive NPV, profits are an increasing function of the size of investment and it is therefore not possible to identify an optimal strategy. From now on, we use the following notation: let $\pi_i(\widehat{x}_i, r_i)$ be the expected utility of final wealth (or gross profit) of the $i \subset \{G, B\}$ bank when playing its optimal strategy and $\pi_i(\widehat{x}_j, r_j)$ be the expected utility of agent $i \subset \{G, B\}$ when deviating to the opponent strategy. A separating equilibrium can arise if and only if the optimal equilibrium strategies satisfy the following conditions:

$$\pi_G(\widehat{x}_G, r_{d,G}) \geq 1 \tag{2.7}$$
$$\pi_G(\widehat{x}_G, r_{d,G}) \geq \pi_G(\widehat{x}_B, r_{d,B}) \tag{2.8}$$
$$\pi_B(\widehat{x}_B, r_{d,B}) \geq 1 \tag{2.9}$$
$$\pi_B(\widehat{x}_B, r_{d,B}) \geq \pi_B(\widehat{x}_G, r_{d,G}) \tag{2.10}$$

We can now examine in details how the expected utility functions are determined. It is easy to determine the expected profits of each bank type when it decides to declare its true type: in both cases, the profit function is the same as that analyzed in the perfect information section. We can therefore rewrite (2.7) and (2.9) as follows:

$$\pi_G(\widehat{x}_G, r_{d,G}) = 1 + \widehat{x}_G \frac{(a_G - 1)}{2} \geq 1 + \frac{(a_G - 1)}{2}$$
$$\pi_B(\widehat{x}_B, r_{d,B}) = 1 + \widehat{x}_B \frac{(a_B - 1)}{2} \geq 1 + \frac{(a_B - 1)}{2}$$

Given our initial assumption on the distribution of returns, in particular that $1 \leq a_B \leq a_G$, the bank's participation constraint is always satisfied for any value of $\widehat{x}_i \geq 1$.

We now come to the analysis of each bank's incentive to lie. The "good" bank might find it optimal to deviate from equilibrium strategy when, for example, the resulting leverage ratio is too low. In this case, the "good" bank might be better off playing any other strategy, even it this would result in investor's applying the "bad" bank cost of funding[12] Moreover, since $\widehat{x}_B$ is the strategy that maximizes the expected utility of the "bad" bank, $\widehat{x}_B$ represent the alternative for which the incentive to deviate is maximum.

When the "good" bank deviates, investor will apply the "bad" bank cost of funding:

$$r_{d,G}(\widehat{x}_B) = \frac{1 + a_B\widehat{x}_B - \sqrt{(1 + a_B)\widehat{x}_B(2 + (-1 + a_B)\widehat{x}_B)}}{-1 + \widehat{x}_B}$$

The impact of deviating on the probability of default is dual: it increases due to an higher cost of funding; the higher the return promised to debtholders, the lower is the probability that returns on investment are high enough to cover that costs. On the other side, higher leverage reduces the capital buffer, implying a higher probability of default; this effect is although marginally decreasing with the size of leverage.

[12]This is a consequence on the assumption of the out of equilibrium believes we made earlier: investor believe indeed that whoever deviates from the "good" bank strategy is the "bad" bank.

The resulting probability of default is:

$$PD_G(\widehat{x}_B) = \frac{\widehat{x}_B + a_B\widehat{x}_B - \sqrt{(1+a_B)\widehat{x}_B(2-\widehat{x}_B+a_B\widehat{x}_B)}}{\widehat{x}_B + a_G\widehat{x}_B}$$

Finally, the change in the probability of default is going to be more substantial when the initial level of $\widehat{x}_G$ is low, both in absolute term and comparatively with $\widehat{x}_G$. When the chosen strategy imply a high leverage, then the main driver of the probability of default is given by the expected returns over investment. Both the cost of debt and the probability of default are concave function of the leverage and converge asymptotically to a finite level uniquely determined by the distribution of returns. The advantages of signalling are therefore a decreasing function of the optimal leverage chosen. This is an important factor of our model as it limits the region in which the incentive constraint is feasible, that is so say when the "bad" bank optimal strategy is "not too high" in absolute term. Altogether the incentives for the "good" bank to lie can be summarized in the following profit function:

$$\begin{aligned} \pi_G(\widehat{x}_B, r_{d,B}) &= (1-PD_G(\widehat{x}_B))E(\widehat{x}_B(\tilde{r}_G - r_{d,B}) + (1+r_{d,B}(\widehat{x}_B))|\tilde{e}_{1,G} > 0) \\ &= \frac{\left(-a_B\widehat{x}_B + a_G\widehat{x}_B + \sqrt{(1+a_B)\widehat{x}_B(2+(-1+a_B)\widehat{x}_B)}\right)^2}{2(1+a_G)\widehat{x}_B} \end{aligned}$$

The"good" bank's profits from deviation using the opponent's equilibrium strategy are an increasing function of a_B, a_G and $\widehat{x}_B$.This can be easily shown by studying the sign of the partial derivatives with respect to the mentioned variables and taking into account that for $\widehat{x}_B$ to be an equilibria it must be at least bigger or equal than one.

Intuitively, the higher the "bad" bank expected returns, the lower are the effects of an increase in the cost of funding when the "good" bank is perceived to be the "bad" one. On the other side, an higher a_G increases the skewness of the distribution of conditional returns; ceteris paribus, it therefore contributes positively to the expected returns given the non default event even if that event is triggered by a higher cost of funding. Finally, the marginal contribution of an increase in the level of the"bad" bank optimal strategy to the incentive of cheating is positive; while the returns on the portfolio are linearly increasing in the size of investment, the cost of debt and the probability of default are concave function of it. For very big sizes of investment, the cost of debt is almost constant, as the marginal contribution of the equity buffer is low.

On the other side, the "bad" bank has an incentive to deviate from the equilibrium strategy only if the reduction in costs associated with a lower cost of funding is higher than the reduction of revenues due to a lower size of the investment. Once again the benefits of deviating can be higher than the costs only if the difference between the two optimal strategies is "low" in absolute terms (such that the intra-marginal loss over the investment is limited). As the cost of debt is a concave function of leverage, the marginal gain in interest payment is higher the lower the leverage ratio; this implies that, when both banks' equilibrium strategy are "high" enough, the chances of having a separating equilibrium are uniquely determined by the spread between the two banks' expected returns.

When the "bad" bank deviates and plays the "good" bank strategy, investor trust him to be the "good" agent, and will therefore apply the latter cost of funding:

$$r_{d,B}(\widehat{x}_G) = \frac{1 + a_G\widehat{x}_G - \sqrt{(1+a_G)\widehat{x}_G(2+(-1+a_G)\widehat{x}_G)}}{-1+\widehat{x}_G}$$

As we did before, we can now compute the probability of default of the "bad" bank when lying. That is given by:

$$PD_B(\widehat{x}_G) = \frac{\widehat{x}_G + a_G\widehat{x}_G - \sqrt{(1+a_G)\widehat{x}_G(2-\widehat{x}_G+a_G\widehat{x}_G)}}{\widehat{x}_G + a_B\widehat{x}_G}$$

The probability of default increases with the "good" bank chosen size, even if the contribution to the growth is marginally decreasing; as in the previous case, the equity buffer effect is decreasing in the size of investment and therefore the probability of default is a concave function of it. The resulting expected profits of the "bad" bank when deviating are given by:

$$\begin{aligned}\pi_B(\widehat{x}_G, r_{d,G}) &= (1-PD_B(\widehat{x}_G))E(\widehat{x}_G(\tilde{r}_B - r_{d,B}) + (1+r_{d,B}(\widehat{x}_G))|\tilde{e}_{1,B} > 0) \\ &= \frac{\left(a_B\widehat{x}_G - a_G\widehat{x}_G + \sqrt{(1+a_G)\widehat{x}_G(2+(-1+a_G)\widehat{x}_G)}\right)^2}{2(1+a_B)\widehat{x}_G}\end{aligned}$$

The "bad" bank profits from deviating are, once again, an increasing function of the size of investment and of the expected returns of the "good" bank. The latter effect is obtained as investor charge a lower cost of funding to the "good" bank when its expected returns are higher. Finally, this profits are an increasing function of the "bad" bank's own expected returns on investment, as a better distribution of returns lowers the probability of default.

It is important to compare the different incentives from deviating for both banks. The "good" bank would prefer mimick the "bad" bank when its chosen size of investment is high compared to its own. On the contrary, the "bad" bank would prefer revealing to be the "good" one only if the size of the "good" bank investment is not too different from their own. At the same time, both bank would rather invest more than less, as their profit functions are always increasing in the size of investments.

We can therefore rewrite the participation and incentive compatibility constraints as follows:

$$\widehat{x}_G \geq 1$$
$$\widehat{x}_B \geq 1$$
$$1+\widehat{x}_G\frac{(a_G-1)}{2} \geq \frac{\left(-a_B\widehat{x}_B+a_G\widehat{x}_B+\sqrt{(1+a_B)\widehat{x}_B(2+(-1+a_B)\widehat{x}_B)}\right)^2}{2(1+a_G)\widehat{x}_B}$$
$$1+\widehat{x}_B\frac{(a_B-1)}{2} \geq \frac{\left(a_B\widehat{x}_G-a_G\widehat{x}_G+\sqrt{(1+a_G)\widehat{x}_G(2+(-1+a_G)\widehat{x}_G)}\right)^2}{2(1+a_B)\widehat{x}_G}$$

Proposition 2. *When banks can choose freely their investment strategy and there is no whatsoever limit to the size of their portfolios, a self-revealing separating equilibrium does not exist.*

Proof. We prove by contradiction that there does not exist a strategy $(\widehat{x}_G, \widehat{x}_B)$ such that the incentive constraint hold. Suppose the proposition is false and let $(\widehat{x}_G, \widehat{x}_B)$ be the equilibrium strategies; as so they are the optimal response strategy played by each bank. Suppose also they are finite. The "good" bank's profits from deviating are given by

$$\frac{\left(-a_B\widehat{x}_B+a_G\widehat{x}_B+\sqrt{(1+a_B)\widehat{x}_B(2+(-1+a_B)\widehat{x}_B)}\right)^2}{2(1+a_G)\widehat{x}_B}$$

and as we have seen before, they are an increasing function of x_B. Therefore, it is always optimal for the "good" bank to deviate and choose an unlimited amount of investment and obtain unbounded positive profits. There is no bounded strategy $\widehat{x}_G$ able to replicate the unbounded profits generated by deviating from the equilibrium. Moreover, there isn't an optimal bounded strategy for the "bad" bank: as before, any unbounded strategy generates higher expected profits. This contradicts our initial assumption about the optimality of the investment strategy, whenever the strategy are finite and bounded. □

2.5 Separating equilibria with capital requirements

In the previous section we have shown that a separating equilibria in which the "good" bank signal its true type with the use of a lower leverage ratio does not exist when banks are unconstrained in their asset allocation decision. The main reason of that being the impossibility of defining an optimal finite strategy for each bank. The "good" bank's profit function when deviating is indeed always increasing in the size of investments: it is therefore impossible to identify a finite strategy that incentives the bank not to deviate when the possible profits from deviating, and choosing an infinite strategy, are not bounded[13].

In this set up the introduction of capital requirement is crucial in generating a signaling equilibria: by limiting the size of investment each bank can undertake, hence by limiting the maximum achievable profits, the regulation generates incentives for a separating equilibrium. The necessary condition for this is, indeed, that profits form deviating are finite and bounded.

We assume that the regulator's objective function is that of generating a separating equilibria (i.e. we assume that a separating equilibrium is socially welfare improving). The choice of parameter defined in the VaR capital requirement is therefore fundamental to achieve this goal. The optimal choice must, moreover, trade-off two different forces affecting the banks' incentives: on one side, the "bad" bank is willing to self-reveal only if the gains from a higher investments are higher than the increased costs of funding; that is to say, the "bad" bank has the correct incentive to self-reveal iff the leverage ratio it can use is "high enough". On the contrary, the "good" bank is better off deviating when the opponent's strategy is "high enough" compared to that it is allowed to.

Moreover, the trade-off between high and low leverage depends on the actual distribution of returns of each bank. That is to say, when the difference between the "good" and "bad" bank expected returns is low, the "good" bank does not pay a substantially higher rate for borrowing, while the other is less prone to mis-report as the gains would be limited. In this case, it is very likely that the "good" bank's incentive constraint is not satisfied when the "bad" bank leverage is sufficiently high. On the contrary, when this difference is high, the "good" bank has an higher incentive to signal its true type as the "bad" bank is more willing to imitate. Here, the "bad" bank incentive constraint might not be satisfied if the leverage is not sufficiently high.

The regulator must therefore trade-off between those two different incentives, and define the maximum leverage ratio that satisfy both banks incentive constraints: a leverage ratio that is high enough for the "bad" bank to reveal itself, but not too high such that the "good" one is not willing to misreveal.

Moreover, the mentioned ratio must rely, in absolute term, within the region in which the capital buffer is still an effective tool in determining the cost of funding and the probability of default. This means that the leverage ratio must not be too high in absolute terms either. Unless the difference in expected returns between the two banks is very substantial, the benefits from self-revealing are a decreasing function of the ratio itself.

[13]This fact is mainly driven by our initial assumption of risk neutrality; when agents are risk averse this might not be true.

We will now analyze the existence of a specific signalling equilibrium, that for which the expected profits of each bank when self-revealing are equalized. This is indeed the case in which the gains from deviating are minimized.

We will now proceed as follows: we will assume that the optimal equilibrium strategy are those for which the expected profits of each bank are equalized. We will then define the regulator optimal choice of β that binds the "good" bank incentive constraint; finally we will need to prove that the other bank's participation constrain is satisfied as an inequality, at least for certain parameters of the distribution.

Let $\{x_G, x_B\}$ be the "good" and "bad" bank strategy in a separating equilibrium. The regulator and the investors can discriminate between the banks when they choose this strategy. Moreover, we are assuming that this are self-revealing strategy; therefore the banks themselves know that, when playing $\{x_G, x_B\}$ everybody knows their true type.

Let's now clarify the role of the regulator in this game. As we sow before, the regulator imposes a capital requirement in the form of a VaR constraint. This in turn implies a leverage ratio constraint in our model of a portfolio constituted by a unique asset. The optimal regulation is therefore uniquely characterized by the choice of β, the probability that the net returns on the assets are lower than the portfolio VaR. As before the higher the β chosen, the higher the banks can leverage up.

The regulator could decide to impose two different β for each bank, but that would not be necessary in our set up. When it chooses a single parameter, it indeed knows that it will only be binding for the "bad" bank; when a separating equilibrium exist, the other bank will automatically choose a lower leverage ratio. It is therefore unimportant to specify two βs for each bank as one is sufficient to generate a signalling equilibrium.

We therefore assume that the regulator uniquely specifies one β parameter; this will bind the "bad" bank optimal decision but not the "good" one. The regulator's aim when fixing β is that of generating a separating equilibrium.

Let's now go back to the banks' behavior. We are here studying the separating equilibrium under which the expected profits for each bank are equalized. We therefore have:

$$1 + x_G(\frac{a_G - 1}{2}) = 1 + x_B(\frac{a_B - 1}{2})$$
$$x_G = x_B(\frac{a_B - 1}{a_G - 1})$$

We have seen before in the symmetric information case that profits are always an increasing function of the size of investment and that capital requirement, aimed at capping that size, would always be binding. The same is true here, since in the separating equilibrium the asymmetry of information is dissolved. When the regulator fixes a unique β, the optimal strategy played by the "bad" bank is:

$$x_B = \frac{1}{1-\beta(a_B+1)}$$

This result is obtained by applying the capital requirement constraint to the "bad" bank that truthfully self-reveal the actual distribution of its returns. As explained earlier:

$$\begin{aligned}
&\beta = \Pr(x_B\tilde{r} \leq -VaR) \\
&(1-\beta) = \Pr(x_B\tilde{r} \geq e_0) \\
&(1-\beta) = (\frac{e_0 + x_B a_B}{x_B})(\frac{1}{1+a_B}) \\
&x_B(1-\beta(a_B+1)) = e_0
\end{aligned}$$

So this equation is the same as the previous one given our additional assumption that the initial endowment is normalized to one.

We can now express x_G as a function of β:

$$x_G = \frac{1}{(a_G-1)}\frac{(a_B-1)}{1-\beta(a_B+1)}$$

The banks' participation constraints are satisfied when both x_B and x_G are bigger or equal to one. This imposes already a restriction on the value the β parameter can take; in particular:

$$\begin{aligned}
&\frac{1}{(a_G-1)}\frac{(a_B-1)}{1-\beta(a_B+1)} \geq 1 \\
&a_B - 1 \geq (a_G-1)(1-\beta(a_B+1) \\
&\beta \geq \frac{(a_G-a_B)}{(a_B+1)(a_G-1)}
\end{aligned}$$

At the same time the "bad" bank participation constraint implies:

$$\begin{aligned}
&\frac{1}{1-\beta(a_B+1)} \geq 1 \\
&\beta \leq \frac{1}{(a_B+1)}
\end{aligned}$$

Therefore taking both condition into account, the bank's participation constraints are satisfied for:

$$\frac{(a_G-a_B)}{(a_B+1)(a_G-1)} \leq \beta \leq \frac{1}{(a_B+1)}$$

It is easy to verify that inside this interval the probability is always bounded between zero and one, for all values of a_B,a_G that satisfy the initial assumption of our model:$1 \leq a_B \leq a_G$.

We can now rewrite both bank incentive constraint and substitute the generic strategies with those defined above. The "good" bank incentive constraint therefore becomes:

$$1+\frac{-1+a_B}{2(1-(1+a_B)\beta)} \geq \frac{(1-(1+a_B)\beta)\left(\frac{-a_B+a_G}{1-(1+a_B)\beta}+\sqrt{\frac{(1+a_B)\left(2+\frac{-1+a_B}{1-(1+a_B)\beta}\right)}{1-(1+a_B)\beta}}\right)^2}{2(1+a_G)}$$

and the "bad" one is:

$$1+\frac{-1+a_B}{2(1-(1+a_B)\beta)} \geq \frac{(-1+a_G)(1-(1+a_B)\beta)\left(\frac{(-1+a_B)(a_B-a_G)}{(-1+a_G)(1-(1+a_B)\beta)}+\sqrt{\frac{(-1+a_B)(1+a_G)\left(2+\frac{-1+a_B}{1-(1+a_B)\beta}\right)}{(-1+a_G)(1-(1+a_B)\beta)}}\right)^2}{2(-1+a_B)(1+a_B)}$$

We can now note two important facts: first of all, since the left hand side of both equation are the same (as we are studying the case in which the banks' expected profits are equalized), while the right hand sides are different, it is not possible that both constraint bind at the same time. That is to say, only one will be binding, while the other holds as a strict inequality. Secondly, the unique variable that determines whether the constraint are satisfied or not is β. This means that the regulator, when choosing the optimal policy, is indeed able to induce a separating equilibrium.

The choice of β is therefore fundamental for the existence of the equilibrium itself. To simplify our exposition we study the case in which the regulator fixes a β parameter such that the "good" bank incentive constraint is binding. To find the actual solution for β we can solve the above equation for it. Given that solution, we can verify whether the other constraint holds as well.

The optimal β chosen by the regulator is the solution to the following equality:

$$1+\frac{-1+a_B}{2(1-(1+a_B)\beta)} = \frac{(1-(1+a_B)\beta)\left(\frac{-a_B+a_G}{1-(1+a_B)\beta}+\sqrt{\frac{(1+a_B)\left(2+\frac{-1+a_B}{1-(1+a_B)\beta}\right)}{1-(1+a_B)\beta}}\right)^2}{2(1+a_G)}$$

$$\frac{(a_B+1)(1-2\beta)}{2(1-\beta(a_B+1))} = \frac{(-a_B+a_G+\sqrt{(1+a_B)^2(1-2\beta)})^2}{2(1+a_G)(1-\beta(a_B+1))}$$

$$(1-2\beta)(a_B+1)-(a_G-a_B) = 2\sqrt{(1+a_B)^2(1-2\beta)}$$

This is just a second order equation in β that can be easily solved. Among the two real solution, we discard the negative one as probabilities can never be negative. The regulator choice for beta is therefore:

$$\beta = -\frac{1 + a_B + a_G + a_B a_G - 2\sqrt{(1+a_B)^3(1+a_G)}}{2(1+a_B)^2}$$

This solution for β is consistent with the equilibrium if it satisfies the condition under which the banks' are willing to participate. It must therefore be the case that:

$$\frac{(a_G - a_B)}{(a_B+1)(a_G-1)} \leq \frac{1 + a_B + a_G + a_B a_G - 2\sqrt{(1+a_B)^3(1+a_G)}}{2(1+a_B)^2} \leq \frac{1}{(a_B+1)}$$

This set of inequalities are indeed satisfied uniquely for certain values of the parameters, which is to say for those value of a_G that are big enough to induce the "good" bank to signal itself, but not too high such that the "bad" bank incentives to deviates are limited.

The subset of values for which the solution for beta is coherent with a separating equilibrium can be summarized as follows:

$$\begin{aligned}
&-1 + 2a_B + 2\sqrt{-1 + {a_B}^2} \leq a_G \\
&a_G \leq a_B + \sqrt{-1 + {a_B}^2 + \left((-1 + {a_B}^2)^2\right)^{1/3}} + \\
&+ \sqrt{-2 + 2{a_B}^2 - \left((-1 + {a_B}^2)^2\right)^{1/3} + \frac{2a_B\left(-1 + {a_B}^2\right)}{\sqrt{-1 + {a_B}^2 + \left((-1 + {a_B}^2)^2\right)^{1/3}}}}
\end{aligned}$$

The previous equation suggests that when a_B is equal to one, such that the "bad" bank investments have zero net present value, it is then not possible to have a signalling equilibrium, no matter what the value of a_G might be. This is something fairly intuitive: the "bad" bank expected profits when it faces zero net present value project are zero as well. This is the main idea behind Modigliani Miller irrelevance theory. In this context although the "bad" bank has the opportunity to lie about its type and pretend to be the "good" bank; no matter how small the profits from deviating would be, they are always going to be higher than zero for any positive value of leverage.

Another interesting fact to note is that the a_G parameters grows exponentally with increase in a_B. The difference between the "good" bank actual cost of capital and that it would pay when considered "bad" is decreasing in the level of a_B. The probability of default captured in the spread applied to the borrowings is subject to big changes when a_B is low in absolute term, but is not quite so sensitive to changes in a_B when a_B is sufficiently high. Put it differently, the corporate spread on borrowings are marginally decreasing in the expected values of returns; the derivative of the marginal cost of capital with respect to a_B is negative. This is why, as that grows, the "good" bank will receive an incentive to signal if and only if its expected returns are much higher than the other.

To complete the proof of the existence of this equilibrium, we must verify that also the "bad" bank incentive constraint is satisfied. For this purpose, we remind that, in equilibrium the expected profits of each bank are constant. Moreover, the regulator fixes a beta parameter such that, in equilibrium, the "good" bank is indifferent between deviating or playing the equilibrium strategy as its expected payoffs are equalized. Then, the equilibrium is sustainable if and only if the profits the "bad" bank could get by deviating are lower than those of the "good" bank. This happens to be the case for certain values of the return distribution.

In formulas, we therefore need to show that:

$$1 + \frac{(-1+a_B)}{3+a_G-2\sqrt{(1+a_B)(1+a_G)}} \geq$$

$$\geq \frac{(-1+a_G)\left(\frac{(-1+a_B)(a_B-a_G)}{-1+a_G} + \sqrt{\frac{(-1+a_B)(1+a_G)\left(2+a_B+a_G-2\sqrt{(1+a_B)(1+a_G)}\right)}{-1+a_G}}\right)^2}{(-1+{a_B}^2)\left(3+a_G-2\sqrt{(1+a_B)(1+a_G)}\right)}$$

The denominator of both left and right hand side, $(3+a_G-2\sqrt{(1+a_B)(1+a_G)})$, is positive for $a_G > -1+2a_B+2\sqrt{-1+{a_B}^2}$. This is the same range over which the solution of beta is a valid one. We can therefore concentrate on the study of the numerator:

$$\left(-1+{a_B}^2\right)\left(2+a_B+a_G-2\sqrt{(1+a_B)(1+a_G)}\right) \geq$$

$$(-1+a_G)\left(\frac{(-1+a_B)(a_B-a_G)}{-1+a_G} + \sqrt{\frac{(-1+a_B)(1+a_G)\left(2+a_B+a_G-2\sqrt{(1+a_B)(1+a_G)}\right)}{-1+a_G}}\right)^2$$

then, by expanding the expression to be squared and regrouping the terms, we can obtain the following inequality:

$$\{-\frac{1}{-1+a_G}(-1+a_B)(a_B-a_G)\}({a_B}^2-2a_Ba_G-{a_G}^2-2(-1+\sqrt{(1+a_B)(1+a_G)}+ +\sqrt{\frac{(-1+a_B)(1+a_G)(2+a_B+a_B-2\sqrt{(1+a_B)(1+a_G)})}{-1+a_G}})+2a_G(\sqrt{(1+a_B)(1+a_G)}+ +\sqrt{\frac{(-1+a_B)(1+a_G)(2+a_B+a_G-2\sqrt{(1+a_B)(1+a_G)})}{-1+a_G}}))\geq 0$$

The term in bracket parenthesis is always positive for all $1 < a_B < a_G$. Finally, the "bad" bank incentive constraint holds for those values of (a_B, a_G) for which

$$2+{a_B}^2-2a_Ba_G-{a_G}^2+ +2(-1+a_G)\left(\sqrt{(1+a_B)(1+a_G)}+\sqrt{\frac{(-1+a_B)(1+a_G)\left(2+a_B+a_G-2\sqrt{(1+a_B)(1+a_G)}\right)}{-1+a_G}}\right)$$

is greater or equal than zero. The domain of the above expression is always contained in the domain of the primitive problem; we are therefore sure that for certain real value of the parameter, this function is positive. Finding a close form solution for those variable is instead something more trivial, as the function is of an order higher than four. It is moreover possible to plot it and gain some intuition from the following graph: The curve plotted in the graph represents the difference between the expected profits of the "bad" bank when self-revealing and when deviating to the opponent's strategy. The curve is a function of both the "good" and "bad" bank maximum return; the "bad" bank's ones, plotted on the x axes, range from 1.10 to 1.30; the "good" bank, plotted on the z axes, range from 2 to 5. The signalling equilibrium is therefore sustained for those value of a_B, a_G such that the curve lies above zero (i.e. where the profits from self-revealing are higher than those from deviating).

As we intuitively said before, the signalling equilibrium is achievable when the expected return of the "good" bank are high enough, but not too high. In the case they are too high, the reduction of the cost of borrowing is substantial and this renders the "bad" bank option of dissimulating its true identity more attractive.

Numerical solution is a good option for identifying the region where the curve is positive. Nevertheless, a closed form solution for the parameters can be found, using the concept of pure function. We can indeed prove that for $-1+2a_B+2\sqrt{-1+{a_B}^2} < a_G <$ $\mathrm{Root}\left[-16+16{a_B}^2+{a_B}^4-4{a_B}^3\#1+\left(16-10{a_B}^2\right)\#1^2-4a_B\#1^3+\#1^4\&,2\right]$ the "bad" bank incentive constraint is satisfied. We recall this condition (1).

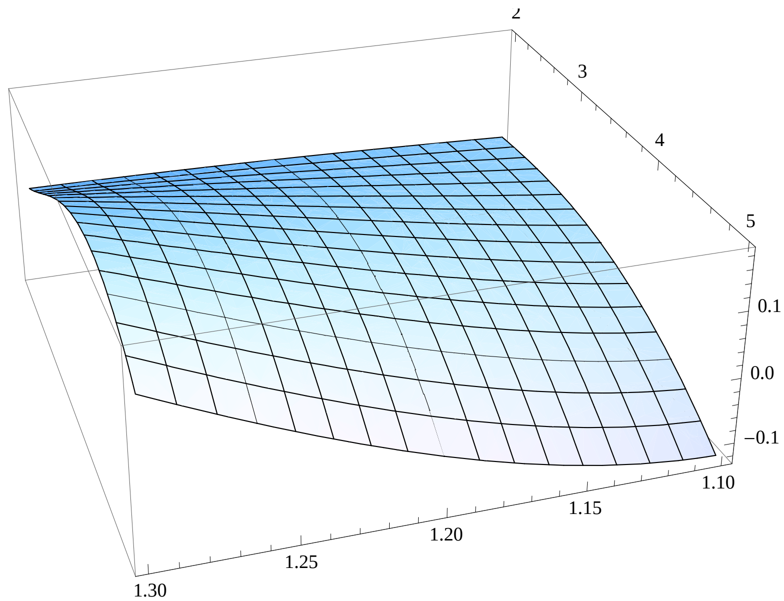

Figure 2.2: Range of parameter under which signalling equilibrium is sustainable
0

We can now summarize all the concept explained in this section, in the following proposition:

Proposition 3. *When agents in the market are asymmetrically informed over the banks' distribution of returns, there is the possibility of achieving a separating equilibrium trough signalling; when the expected returns between the two type is sufficiently high, but not excessively high such that condition (1) holds, the banks' optimal strategy is to self-reveal their true type trough the use of a different leverage ratio. In equilibrium each bank plays:*

$$x_B = \frac{2}{3 + a_G - 2\sqrt{(1+a_B)(1+a_G)}}$$

$$x_G = \frac{2(-1+a_B)}{(-1+a_G)\left(3 + a_G - 2\sqrt{(1+a_B)(1+a_G)}\right)}$$

The "good" bank chose a lower level of leverage, while capital requirement is binding only for the "bad" bank. The banks' expected profits are higher than the reservation utility and equal to:

$$\pi_G(x_G) = \pi_B(x_B) = 1 + \frac{-1+a_B}{3 + a_G - 2\sqrt{(1+a_B)(1+a_G)}}$$

Finally the regulator fixes a value for the capital requirement such that the "good" bank incentive constraint is binding:

$$\beta = -\frac{1 + a_G - 2\sqrt{(1 + a_B)(1 + a_G)}}{2 + 2a_B}$$

2.5.1 Consequences of signalling equilibrium

Throughout the last section, we have assumed that the regulator was aiming at generating a separating equilibrium for the welfare implications this equilibrium might have. At the end of the day, the regulation must be able to achieve the goals it was generated for, which is to say it must limit the negative externalities associated with the bank default. If we assume that there are not positive externalities associated with a separating equilibrium (such as positive externalities for debtholders and stockholders), the regulator choice of enforcing a signalling equilibrium is rational if and only if the equilibrium probability of default are closer to the prefect information outcome than its alternative option, that being enforcing a pooling equilibrium.

In this paper we have not come to the analysis of the pooling equilibrium. In general, if that equilibrium exist, there would be a subsidization of the "good" bank towards the "bad" one. When both banks play the same strategy, the investor are indeed not able to distinguish between the two banks' type, and will therefore charge an average cost of borrowing, based on their ex-ante believes, to each of them. The regulator can only fix one capital requirement, binding for both banks; this in turns implies that the "bad" bank has a higher leverage and higher probability of default than in perfect information while the opposite is true for the "good" bank.

The separating equilibrium is therefore more efficient is the effects of crosssubsidization between the "good" and the "bad" bank are lower thank in the pooling scenarium. In this paper we will not talk about the efficiency of the equilibrium, but we still want to characterize the consequences of signalling on the equilibrium interest rates charged by investors and probability of default, and compare this outcomes with the perfect information case explained in section one.

In perfect information the regulator fixes a unique beta, allowing in turn the "good" bank to gain into a higher leverage ratio than its opponent. The probability of defaults are therefore determined uniquely by the regulator's choice of beta. In the presence of a unique beta, both banks will have the same probability of defaults. This is the most important difference with the separating equilibrium studied: the "good" bank can signal itself only with the use of a lower leverage ratio. This generates already an inefficiency in the equilibrium: either the "good" bank investments are lower than in perfect information, or the "bad" bank ones are higher. In turns, either the "good" bank probability of default is too small, or the "bad" one is too high, or both. In this terms the separating equilibrium will never be first order efficient, although it could be the second best efficient solution when compared to a pooling equilibrium.

Since the total amount of investment is inefficient, we can estimate the cost of separating equilibrium by looking at the difference between the optimal amount of investments when investor are fully and asymmetrically informed. Suppose that the regulator optimal choice of beta is invariant in the two scenarios: $\beta^{FI} = \beta^{AI} = (2\sqrt{(1+a_B)(1+a_G)} - (a_G+1))/(2(1+a_B))$. The resulting level of investment for the good bank in full information, as show in the initial section of our analysis, is simply given by: $1/(1-\beta^{FI}(a_G+1))$, which implies:

$$x_G^{FI} = \frac{2(1+a_B)}{2(1+a_B) - (1+a_G)\left(-1-a_G+2\sqrt{(1+a_B)(1+a_G)}\right)}$$

At the same time, we have shown before that in a separating equilibrium the optimal strategy chosen by the good bank is equal to:

$$x_G^{AI} = \frac{2(-1+a_B)}{(-1+a_G)\left(3+a_G-2\sqrt{(1+a_B)(1+a_G)}\right)}$$

On the other side, the capital requirement ill bind the "bad" bank investment level at the same point, therefore $x_B^{FI} = x_B^{AI} = 2/(3+a_G-2\sqrt{(1+a_B)(1+a_G)})$. The total costs of asymmetric information under separating equilibria can therefore be described by the difference between x_G^{FI} and x_G^{AI} when the regulator keeps the level of beta constant.

As a consequence of the "good" bank underinvestment, the interest charges paid to investor are lower than under full information. The same is true for the probability of default.

A full analysis of the efficiency of this equilibrium must therefore compare the cost function of signalling and pooling equilibrium. Since our primary concern in this paper was to prove that capital requirement are a valid instrument to gather information from the bank's manager, we only focused on the analysis of a signalling equilibrium. We therefore leave this question open for further studies.

2.5.2 Manager's hiring decision under separating equilibrium

We now come to study the managers' hiring decision when asymmetric information is resolved trough signalling. For the hiring process, we refer to the set up of the game exposed in section 3.3 in which two banks compete to hire the human resources of different ability. In that section we proved that there exist a unique Nash equilibrium for the wage bargaining in which the managers were paid the full amount of the profits generated minus a fraction of the fixed hiring costs. Therefore the "good" manager was paid more than the "bad" one and both wage schedule were convex function of the level of investment.

But we also showed that there is one condition that needs to be satisfied in order for the equilibrium to hold; this condition says that the expected profits of any bank when hiring the "good" manager need to be sufficiently high. When this condition is satisfied, the high ability worker participation constraint is satisfied and he is willing to accept the wage offer. We remind indeed that the "good" manager always accepts the offer for any $w_G \geq \max\{\bar{u}, w_B\}$. This is due to the fact that the "good" manager has positive outside option, equal ti $\bar{u}$, and can't be paid less then the low ability worker.

The "good" manager participation constraint becomes trivial in the hiring process that supports a separating equilbrium. When the separating equilibrium exists, it indeed implies that either bank expected returns are equal: $\pi_G = \pi_B$. Irrespectively of the ability of the manager hired, the expected profits of the banks are the same.

In the previous context we proved that the equilibrium wages were $\pi_G - 3/2F$ for the high type and $\pi_B - 1/2F$. When $\pi_G = \pi_B$, proposition one implies that the "good" manager is paid less than the "bad" one. This can not represent an equilibrium in the current environment. The "good" manager's participation constraint indeed says that $w_G \geq \max\{\bar{u}, w_B\}$, else that the "good" manager prefers exercising his outside option when the market does not prize correctly his ability.

When the expected profits of the "bad" manager is sufficiently high, such that $\pi_B \geq \bar{u}$, the equilibrium wages is therefore represented by: $\{w_G, w_B\} = \{(\pi_B - 1/2F), (\pi_B - 1/2F)\}$. Therefore, each manager is paid the same wage, irrespectively of its true ability; the "good" manager accepts to work for bank 1 and the "bad" one for bank 2; both banks realize the same expected profits equal to $1/2F$.

Competition between banks implies that managers are remunerated in proportion to the expected profits they generate. Asymmetric information generates a socially inefficient level of investment for the bank that had hired the "good" manager that translates in a lower level expected profits. In particular, the cost of signalling results in each bank sharing the same expected profits. Only when this profits are high enough the "good" manager is willing to accept the offer and renounce to their outside option.

If, due to asymmetric information, the banks can't afford hiring the "good" manager, as their expected profits are insufficient to meet his participation constraint, the market faces an adverse selection problem: only the "bad" manager is hired by both bank. This is although not consistent with the Baysian rule of updating expectation and the signalling equilibrium described in the previous section breaks down.

We can now synthesize our reasoning in the following proposition:

Proposition 4. *Let there be two banks competing for two managers with different ability. Managers ability is reflected in different net present value of the investment opportunity they face; nevertheless, both NPVs are positive. Each bank hires one manager by offering an acceptable wage. Market participants are asymmetrically informed and can't foresee which bank hired the high ability worker. In this context there exist a self-revealing signalling equilibrium if and only if the expected profits of banks net of the cost of signalling are sufficiently high as to meet the managers' reservation utility,*

$$1 + \frac{-1 + a_B}{3 + a_G - 2\sqrt{(1 + a_B)(1 + a_G)}} \geq \bar{u}$$

2.6 Conclusion

In this paper we have outlined a model of capital structure in which we allowed the banks to signal their true quality to market participants. We have shown that, under some assumption about the distribution of assets' returns, a separating equilibrium is enforceable. In this equilibrium, the "good' bank decide to signal itself trough the adoption of a lower leverage target. This result is in contrast with the general theory of corporate finance signaling, under which the "good" firm generally signal its quality trough a high leverage.

We have shown the importance of capital requirement in the determination of the equilibrium. Without any constraint, a separating equilibrium would not be feasible. The regulator choice on the parameter that defines the capital requirement constraint are fundamental in determining the equilibrium. Further work should focus on the regulator decision rule, which we have so far taken as exogenous.

Chapter 3

An investigation on Banks' Leverage cross-section

3.1 Introduction

3.1.1 Motivation

Part of the literature that studies banks' regulation and actual policymakers' decisions is based on the presumption of the irrelevance of banks' capital structure. The fundamentals of this presumption include the idea that banks hold capital because of regulatory capital requirements but would rather avoid doing so in an unconstrained world to improve shareholders' returns. Capital requirements, motivated by industry-wide safety concerns, determine value dissipation for each bank institution and require substituting cheaper deposits with more costly equity.

If this is true, banks would minimize the dissipation in their value by choosing the minimum level of equity consistent with the regulation; the capital structure would then merely be the effect of a binding capital requirement, and its study would not help in understanding banks' decision rules. The main implication of this way of reasoning is that the cross-sectional variation of banks' capital structure should be predominantly driven by the level of risk intrinsic in the banks' assets and that capital buffers should always be zero. Basel I and Basel II regulations indeed introduce a risk-sensitive capital requirement that limits the ratio between the risk-weighted asset and a measure of the regulatory capital, defined as tier one; when the requirement is binding, this ratio is equal to 6%, thus $\frac{TIER1}{RWA} = 6\%$. Suppose that we could measure the risk-weighted assets as the product of the value of total assets (TA) times a synthetic measure of their risk (σ_A). We could then rewrite the equality as $\frac{E*\frac{TIER1}{E}}{TA*\sigma_A} = 6\%$. Solving for the leverage ratio, we obtain

$$\frac{TA}{E} = \frac{TIER1}{6\% * (E * \sigma_A)}$$

. The leverage ratio should be negatively related to the level of risk of the assets and positively with the fraction of equity with respect to the banks' tier 1. Therefore, no other factors should then influence banks' capital structure.

The empirical evidence generally negates the general wisdom concerning the irrelevance of capital structure; it has indeed been shown that banks hold significant positive capital buffers (they retain more capital than that prescribed by the regulator). Therefore, the first empirical evidence is that the capital requirement is not determining banks' investment decisions. The other evidence is that there is a wide variation in banks' capital structures; because the capital structure's irrelevance breaks down with the initial evidence, it is worth understanding what factors can explain the observed variation.

This paper proposes a cross-sectional study on banks' capital structure; in particular, we test here whether signaling is an explanatory variable of the cross-sectional variation of banks' leverage. In the signaling model discussed by us in the previous chapter, we proved, under certain conditions, the existence of a signaling equilibrium under which better-quality managers try to convey their private information to market participants through a lower level of leverage. In equilibrium, good managers chose the level of leverage that perfectly trades off the cost of having a lower leverage ratio, the opportunity cost of forgoing profitable opportunities, and with its benefit, relating to a lower cost of funding. The cost of funding is lower not just because of a lower leverage and thus because of a lower probability of default but also because the market perceives the intrinsic good quality of the banks' assets.

We therefore propose a test of the signaling equilibrium based on the relation between leverage and assets' quality. We adopt two different approaches to define assets' quality, which is an unobservable variable. In the first approach, we proxy assets' quality with the past series of return on assets, as better-quality assets should present a better series of past returns. In the other approach, we define assets of bad quality as those that characterize banks that failed in the period 2008-2010; good banks have indeed a much smaller probability of default than bad ones.

Our empirical analysis supports the idea that managers target a leverage ratio level to reveal information about their intrinsic quality; we indeed find a negative and significant relationship between leverage and banks quality. No other capital structure theory predicts a negative relationship between leverage and asset quality[1], and we

[1] Other corporate finance models, as in Ross (1977), predict a positive relationship between corporate leverage and firm's value; the trade-off theory generally predicts that firms with higher profitability should lever up more to increase the value of their tax shield; finally, the pecking order hypothesis pre-

therefore interpret this result as an evidence of a signaling equilibrium.

3.1.2 Related Literature

There are two main contributions that study the determinants of the cross-sectional variation of banks' capital structure in the recent literature. Mehran and Thakor (2010) find a strong and statistically significant relation between the goodwill paid in some recent M&A transactions and the capital-to-asset ratio of the targeted bank; they conclude that banks' value, captured in the goodwill, depends positively on the capital ratio: good banks tend to have a lower leverage ratio. They interpret this result following a theoretical model developed in the paper; the main proposition of the model affirms that in equilibrium, better-quality banks are those with a higher capital ratio: capital has indeed a positive direct effect on the bank's value through increasing the probability of survivorship, and an indirect one trough an increase in the incentives of loan monitoring. Monitoring incentives increase as forward-looking managers perceive higher benefits from monitoring when capital is higher, as the probability of a bank's default is lower (hence a higher probability of being remunerated in the future). A stronger monitoring of loans implies in turn a higher quality of the assets.

Mehran and Thakor conduct their empirical analysis upon a sample of banks that have recently been part of an M&A deal as targets. The authors use the ratio of goodwill, a measure of the difference between the price paid and the market value of equity (which in turn represents the difference between the market value of assets and liabilities) over total assets as a proxy for a bank's value. In practice, although the price paid in acquisitions could well be affected by other economic factors than the intrinsic quality of the purchased assets, these factors can include the evaluation of positive synergies (economies of scale and scope) and can derive from higher monopolistic rents, from management's empire-building attitude and/or from the gains of becoming a too-big-to-fail institution. In our empirical analysis, on the contrary, we focus on understanding the relation between asset quality and leverage. Asset quality and asset value are indeed two separate concepts: the quality is the intrinsic characteristic of the assets that determines the distribution of returns, whereas the value incorporates a potentially subjective valuation from the valuer and depends on both the quality and the size of the assets. In our empirical study, we therefore try to explain how the cross-sectional variation of leverage depends on a bank's intrinsic quality; this is indeed the kind of relation we need to look at for a test of market signalling.

In a different paper, Gropp and Heider (2009) find that the general variables used to explain the cross-sectional variation in firms' leverage are also valid for the banking

dicts that more profitable firms should have a higher value of past retained earnings, which contributes negatively to firms' leverage.

sector. The sample of the data observed contains the 100 largest European and American banks, ranked by market capitalisation. The regression model used is a standard corporate finance model that relates leverage to some banks' specific factors, such as profitability, size, dividend policy and unobserved fixed effects. In agreement with the general corporate finance findings, they prove a positive relation between leverage and bank's size, and the value of its collateral, and prove a negative one between leverage and a bank's profitability, market-to-book ratio and dividends. The authors' main conclusions primarily concern two points: first, they find a significant explanatory power of banks' unobserved fixed effects; second, they find that capital requirement regulation (based on the effective risk taken) is only a secondary factor in the determination of a bankÕs leverage, as including a risk variable in the regression does not at all modify the standard determinants defined in the corporate finance literature.

In our paper, we collect data from the largest publicly traded banks in US and Europe as well as in Gropp and Heider (2009); unlike them, we treat the two samples separately in the regression: we believe indeed that differences in accounting standards invalidate any cross-border comparison; it is very possible that the results obtained by the authors about the significance of the bank's unobserved fixed effects is driven by the heterogeneity in accounting standards. The authors also derive a negative relation between profits and leverage; instead, our model measures the relation between asset quality and leverage; profits are not a good approximation of a bank's quality mostly because they depend on the size of the investment and on other factors (such as the accounting policy) other than the direct profitability of the assets. However, the authors find a negative relation between banks' profits and leverage.

In a less recent analysis, Berger et al. (1995) studies the relationship between capital-to-asset ratio (CAR) and the returns on equity of US banks and finds a positive relationship, both statistical and economic, that holds both cross-sectionally and for each year when lags are included and that becomes even stronger when an extensive set of control variables is added to the regression. More importantly, Berger tries to determine a potential explanation of this (counterintuitive) finding. Particularly interesting for our purposes is his analysis of the signaling hypothesis, which he interprets as the attempt of bank management to signal private information that future prospects are good by increasing capital; following this interpretation of a signaling equilibrium, an increase in CAR should be followed by either higher revenues, lower operating income or the lower risk of the assets. The author tests whether there is an improvement in either revenues or operating costs following capital increases and finds no evidence of signaling. Moreover, he finds no difference between the results obtained for banks that actively manage their CAR and banks that behave only passively (trough earnings retention); this again is evidence against signaling, as this requires that the capital decision is a voluntary optimal choice.

The interpretation of a signaling equilibrium that we want to test is different than that presented in Berger; what the managers want to signal is indeed the intrinsic quality of the assets, but because returns on assets are still random, there might not be a direct effect between the market signal and the realized return in the period following the signal. For this reason, we look at the relation between asset quality and leverage and find a significant negative relation, which we interpret as the will of good banks to reveal themselves through a lower level of leverage.

A difference between our paper and those mentioned earlier is the econometric model employed in the regression. We follow the model developed by Flannery and Rangan (2006), which accounts for the potentially dynamic nature of a bank's capital structure. The model allows each bank's targeted leverage to vary over the years and allows for deviation from the optimal target. Deviation may be well economically justified by external costs of adjustment; due to this cost, banks can indeed decide to move towards their desired leverage target through time and to close each period a fraction λ of the gap between desired and actual leverage. With this particular model, the authors find evidence that firms converge toward their long-run target at a rate of more than 30% a year and that a partial adjustment model with firm fixed effects fits the data very well.

Berger et al. (2008), Jokipii and Milne (2008) and Ayuso et al. (2004) all propose recent studies of the banks' capital structure aimed at explaining the compelling (from a theoretical point of view) phenomena of capital buffers. Bank holding companies hold capital in excess of the minimum capital standards by a material amount in every period between 1992 and 2007. At the same time, the leverage ratio is 100 basis points higher in 2006 than it was in 1992, whereas the risk-based ratio has been almost flat over this time. Because capital requirements limit the investment opportunity of banks and their profitability, it is commonly believed that it should bind banks' decision. It is therefore an interesting question to ask why capital requirements are not binding for the majority of banks.

Berger et al. (2008) test whether banks target a specific capital ratio above the regulatory requirement or if that buffer is a mere consequence of a positive series of accumulated earnings. The authors test whether an active or a passive contribution is stronger in the formation of capital buffers; management could actively choose a given buffer that reflects the economic capital that is actually needed to contrast the bank's actual risk exposure or to catch potential growth opportunities, or they could passively (less voluntarily) do so, simply retaining past-year incomes. The authors find significant evidence that an active management approach exists in the observed panel of data; the capital buffers appear to be a mean-reverting process in which the speed of convergence is proportional to the distance from the target. Jokipii and Milne (2006) focus their empirical investigation on understanding the relation between capital buffers and the business cycle; they find a significant negative co-movement of buffers and the business cycle. Following years of economic stability, banks tend to lower their buffer while increasing it when times turn bad (probably because their risk management tools are all fed with historical and recent data). As the authors note, this fact goes to amplify the pro-cyclical prescription of the Basel II regulation. Similar research questions and similar answers are found by Ayuso et al. (2004) using data from Spanish banks.

Our proposed theory is coherent with recent findings in the literature on capital buffers as long as buffers are hold to signal the soundness to the market to obtain funds quickly and at a lower rate of interest. Focusing on leverage or capital buffer is therefore an alternative approach.

3.2 A definition of the dependent variable: Banks' Leverage

In this paper, we focus on the cross-sectional determinants of banks' leverage. Leverage is the sensitivity of the value of equity ownership with respect to changes in the underlying value of the firm. Before proceeding with an empirical investigation over banks' leverage, we must clarify what exactly we mean by it.

The particular role of banks makes their balance sheet unique in the sense that the basic assumption of the Modigliani-Miller framework, that the value of assets is independent from the composition of liabilities, breaks down. Generalizing, we can regroup the liability of banks into four groups: common equity, short-term borrowings, long-term borrowings and demand deposits. The presence of deposits and other kinds of liability issued to the customer completely breaks down the assumption on which the MM proposition was built, as an increase in deposits can imply an increase in the value of the assets. As an example, a commercial bank provides services to customers who fund the bank via demand deposits: the in- and outflows of money from the deposit account provide the bank with useful information that can in turn affect the quality and value of banks' assets.

Clearly, deposits are part of the core mission of commercial banks and are, at the same time, a source of profitability. Banks can indeed try to increase the amount of their deposits for two main purposes: to attract new financial capital with a lower remuneration cost and/or to broaden the number of clients to whom to offer chargeable services. Under this second perspective, some argue that banks' deposits should not be considered in the measurement of financial leverage; in this paper, we challenge this point of view and propose a measure of leverage where deposits are included on the basis that they contribute positively to the sensitivity of equity with respect to banks' value. Equity is indeed junior to both financial debt and deposits; at the same time, financial liabilities are junior to deposits.

To clarify our approach, we propose a simple example based on the liability components of a commercial and merchant bank. Recall that the balance sheet of a bank generally consists of three components,

$$\text{Total Assets} = \text{Financial Debt} + \text{Deposits} + \text{Equity}$$

Consider the following two hypothetical capital structures: In this example, the Com-

	Financial Debt	Deposits	Equity	Total
Commercial Bank	30 million	30 million	40 million	100 million
Merchant Bank	30 million		40 million	70 million

mercial Bank is the most leveraged structure; it has more sensitivity of equity to the underlying asset changes. A 10% of the bank asset base would manifest itself as an equity loss of $(40 - 10)/40 - 1 = -25\%$ for the commercial bank while producing a $(40-7)/40-1 = -17.5\%$ loss for the merchant bank. Therefore, even if deposits can be collected for reasons other than strictly financial ones, their seniority to financial debt and equity increases the sensitivity of equity itself, and they thus have to be considered in the measure of leverage.

For this reason, we use the ratio of total assets over equity as a definition of bank leverage.

3.3 Data samples for the empirical investigation

The goal of this paper is to investigate the cross-sectional determinants of bank leverage; in particular, it is to quantify the relation between leverage and banks' quality, which is the basis for a proof of the existence of a signaling equilibrium. However, a bank's asset quality is not an observable factor; we therefore took two different approaches do identify an observable variable that proxies asset quality; in the next section, we present an ex-ante approach, where asset quality is identified on the basis of the ex-ante expectation of its realization. The other, the ex-post approach, identifies quality as the ex-post observed event that more likely satisfies the prior expectations. Our regression model is therefore applied to both data samples to verify the stability of the relations found over the definition of bank quality.

3.3.1 The ex-ante approach

We collect a sample of 81 commercial banks and bank holding companies, from 1994 to 2008, whose annual data are available from DataStream; the sample includes the top 40 American and European banks in terms of market capitalization as of January 2010. We define European banks as those whose shares trade in Italy, UK, Spain, France, Germany and Switzerland; we first aggregate data of banks with different markets of origin in one unique sample and then select the biggest forty in terms of market capitalization[2]. Because our regression specification includes lagged variables, we must also exclude any firm with fewer than two consecutive years of data. During the chosen period of analysis, all banks included in the sample were subject to the Basel I framework; we are therefore conditioning our results to a specific capital requirement regime.

Gropp and Heider (2008) use a similar panel of data; they include the 100 largest publicly traded US and European banks in their sample. The regression is then run altogether on this mixed-origin sample. We believe this approach to be wrong; the non-homogeneous accounting standard interferes substantially with the quantification of all of the variables. We report in the appendix the main differences between the US GAAP, adopted in the US, and IFRS principles, adopted by European banks. The major differences are driven by different consolidation, netting and asset de-recognition principles that impact both the assets and liabilities sides of the balance sheet; it is not possible to reconcile the different sets of data with publicly available information.

In Table 1 and Table 2, we report the summary statistics of US and European banks, respectively. Not surprisingly, the leverage ratio (measured as the ratio between the book value of total assets and the book value of equity) of US banks is 11.5, much smaller than, basically one half of, that of the European sample, which is equal to 23.7; the difference is primary due to the wider area of consolidation followed by European banks that increases the size of the assets. The logarithm of the size of the asset is indeed higher for European banks than for the US (18.7 against 16.8); European banks are therefore larger in size than American banks. The average capital requirement ratio, measured by the ratio between Tier 1 capital and the sum of risk-weighted assets, is higher for US banks; one could conclude, in our opinion, wrongly, that US banks are better capitalized and thus less risky than European ones. In practice, though, the starting point to calculate the risk-weighted assets is the amount of assets recognized on the balance sheet; we prefer not to derive any conclusion on a bank's soundness based on this ratio, as the amount of assets recognized by European banks is higher but not necessarily riskier. The amount of risk-weighted assets over total assets, a ratio that proxies the level of risk inherent in the projects undertaken, is indeed higher for

[2]Not all European Country is therefore equally present in the sample

US banks (0.74 versus 0.50 for European banks). The average market-to-book value is similar for both samples, as the market probably perceives that they have similar growing opportunities. The mean ratio of net loans to total assets is again similar to both samples, meaning that the activity carried on by commercial banks in the US and Europe is on average similar.

Finally, we consider the ratio of EBIT over total assets, the return on assets (ROA), to be the best proxy for the banks' quality. When investments are ranked by first-order stochastic dominance, for example, the expected return of the dominant asset is higher than that of the dominated one. Because the best measure for the expected return on assets are the observed realized returns (in particular, over long periods of observation, where the lowest of large numbers comes into play), we instrument asset quality with the ROA; we call this way of defining asset quality the ex-ante approach, as it is based on the characteristics that assets with different levels of quality should satisfy on the basis of ex-ante beliefs: good-quality banks are therefore those with a higher ROA.

A negative relation between leverage and ROA can be the proof of the existence of a signaling equilibrium in which banks that expect to have better future performance signal their expectation to the market through higher capital. A possible alternative explanation is given by the pecking-order theory, for which a firm's capital structure follows very closely the financial deficit of firms: more profitable firms tend to have a negative deficits or to retain a higher part of the profits themselves, either way, increasing capital. Different empirical studies from those cited earlier have ruled out a passive approach of banks' capital structure; more evidence provided by Morris and Shin (2008) shows that an increase in asset size is accompanied with an increase in leverage (and not in equity).

Most of the existing literature adopts different standards of bank profitability: widely used are the ROE or net profits. On the contrary, we believe that both return on equity and profits are poor proxies for asset quality; ROE can indeed be seen as the product of the return on assets times the leverage ratio, whereas a measure of profits depends on the size of the investment and on other characteristics of the business model not directly related to asset quality (i.e., amortization, depreciations and structural cost). Only the return on assets can therefore be a meaningful measure of assets profitability.

As shown in Table 1, US banks have on average a higher ratio of EBIT over total assets equal to 2.28%, slightly higher than that of European banks, which is equal to 2.05%, and a lower standard deviation. This evidence may prove that the assets of US banks are on average of marginal better quality than that of their European counterparts.

3.3.2 The ex-post approach

We take here an alternative approach to the identification of banks' quality, based on the ex-post observation of a bank's low asset quality, its failure. In a mixed sample of failed and non-failed banks, we assume that the institutions that ex-post failed were actually those with lower quality ex-ante. This assumption is based on the fact that the ex-ante probability of default of lower-quality banks is higher than it is for higher-quality bank; this is reflected in the realised failure frequency for the low of large numbers.

We obtain a list of failed bank from the FDIC database[3]; this list contains all US institutions that have failed or required assistance from the FDIC between 2008 and 2010. There are 227 US institutions that either failed or required assistance during that period of time. By ranking the observations in terms of asset base, we observe a high variation in the value of total assets for the banks present in our sample. The average value of assets of these institution is 16.4 billion dollars, with a minimum value of only 13 million dollars and a maximum of 1.47 trillion dollars.

The sample therefore contains banks of very different asset sizes; the asset size can in turn influence the strategic decision on optimal capital structure for at least two reasons: first, banks of smaller size have limited exposure to the market and thus a lower opportunity to get financing from the market; more importantly, very large institutions are generally considered too big to fail and can profit from the government's implicit guarantee: the bailout option might generate different incentives regarding the choice of leverage. Not surprisingly, indeed, all banks with asset values bigger than 30 billion dollars have been assisted by the government and avoided failure, with the only exception being Washington Mutual. On the contrary, none of the smaller banks has been able to receive assistance and have therefore failed.

The list includes, for example Bear Stearns, given financial assistance prior to its acquisition of JP Morgan Chase, Citigroup and Bank of America, which have received $50 billion and $45 billion respectively in capital injection from the US Treasury through TARP funds. Among this group of banks, we included Lehman Brothers Holding, which filed for bankruptcy on September 2008. Although Lehman was not a bank, we decide to include it within the group of failed, as the government's financial safety net has been provided beyond depository institution: for the first time in the history of the Fed, the discount window access was extended to investment banks.

Too-Big-to-Fail (TBTF) has become a heated topic of debate in the last few years. The evidence proved that the TBTF policy was at work in the financial crises; this policy allows a bailout when the banking organization's failure would have serious

[3] www2.fdic.gov/hsob/hsobRpt.asp

adverse effects on the economic conditions or financial stability of the economy; at the same time, it can distort banks' investment decisions by representing a base for an extreme moral hazard. Creditors can stop exerting any form of market control under the presumption that, if things go wrong, their debt would be repaid by a state intervention; similarly, banks can find easier access to funding and invest in inefficient assets for the main purpose of remunerating their managers on a short-term basis.

Most of the empirical analysis on this issue shows that becoming a TBTF institution is valued by market participants and carries a wealth effect reflective of this perceived favourable treatment. Kane (2000) shows that the stocks of a megabank acquirer gains value on the announcement date of a merger, in contradiction with the finance literature that establishes that the value of the target's stock increases relative to the acquirer's stock around the merger announcement date. Schmid and Walter (2006) find that the financial conglomerates generally trade at a discount relative to specialised firms, while banks with an asset value larger than $100 billion benefit from a conglomeration premium. Penas and Unal (2004) examine the changes in credit spreads at the date of a merger announcement, finding no significance evidence of changes in bond returns or credit spread when banks are small and a positive reaction when a bank's size is large enough. These cited empirical works (and many other non-cited works) prove the existence of a valuable bailout option in the hands of TBTF claimholders.

To conduct a cross-sectional analysis on banks' capital structure, we need a homogeneous sample of banks. Because the implicit bailout option can distort the dynamics of leverage targeting, we construct our sample of observations conditioning on bank size. We include in our empirical investigation only all those financial institutions with asset values higher than $30 billion (hence all potentially TBTF). The sample includes all the listed US banks that, as of December 2009, satisfied the asset dimension and all those on the FDIC's failed bank list with the same asset characterisation. Finally, we added information on the two TBTF investment banks that defaulted in 2008 (Lehman Brothers and Bear Stearns), which are not present on that list.

Our sample is therefore composed of 35 financial institutions, out of which 9 have been assisted or actually defaulted as of January 2010. We collect quarterly data for this sample between Q1 1994 and Q4 2009. The following table provides descriptive statistics for the variables we use. In the next section, we give a more formal explanation on the meaning of these variables.

Given the sample selection process, the banks in our sample are large. The mean of the logarithm of total assets is 16.8: these banks are therefore bigger in size than those contained in the previous sample of US banks. The mean leverage is higher as well; moreover, the mean leverage of failed banks is larger than that of the non-failed ones.

3.4 The econometric model

The econometric model we adopt is based on a model with partial adjustment toward a target leverage ratio that depends on firm characteristics, similar to that developed by Flannery and Rangan (2006). As a starting point, we model the possibility that the leverage target differs across banks and over time, depending on some bank's characteristics. The leverage target is therefore specified in the following equation:

$$L^*_{i,t+1} = \beta X_{i,t} + \gamma GoB_{i,t} + \epsilon_{i,t+1} \tag{3.1}$$

We interpret the leverage target, $L^*_{i,t+1}$, as bank i's desired leverage ratio at $t+1$; the ideal target depends on $X_{i,t}$, a series of banks' characteristics related to the cost and benefits of operating with various leverage ratios; an innovative figure of our model is the inclusion of a variable that reflects the quality of banks' assets, $GoB_{i,t}$. Our investigation will focus on the particular relation between banks' quality and leverage as a test to prove the signaling incentives of capital structure. Finally $\epsilon_{i,t+1}$ is a well-behaved error term.

Due to adjustment costs, banks can decide to operate with a suboptimal level of leverage; banks indeed trade off the adjustment costs against the cost of operating with suboptimal leverage. A typical example of adjustment costs in the literature refers to the cost of new equity emission: capital is raised less frequently than debt, as it is more exposed to the costs arising from asymmetric information; targeting a leverage ratio by changing capital can indeed prove very costly. At the same time, reducing leverage by selling assets can prove extremely costly during times of stress and may actually be possible only at fire sale price levels.

We adopt a standard model of partial adjustment, written as follows:

$$L_{i,t+1} - L_{i,t} = \lambda(L^*_{i,t+1} - L_{i,t}) + u_{i,t+1} \tag{3.2}$$

in which the change in leverage observed between two consecutive periods is considered an attempt to get closer to the desired level of leverage; that is, each year the bank closes a fraction λ of its target gap, $(L^*_{i,t+1} - L_{i,t})$. By substituting Eq. (1) into Eq. (2), we obtain the final version of our regression model:

$$L_{i,t+1} = \lambda(\beta X_{i,t} + \gamma GoB_{i,t}) + (1-\lambda)L_{i,t} + (u_{i,t+1} + \epsilon_{i,t+1}) \tag{3.3}$$

The actual leverage is therefore a function of its lag value and the banks' characteristics and asset quality, plus a composite error term, which we assume to be well-behaved (i.e., we assume that the $u_{i,t+1}$ and the $\epsilon_{i,t+1}$ component of the error term are independently normally distributed). The λ term represents the part of leverage that banks actively manage each period; its complement, $1 - \lambda$, represents the inertial part of leverage. If banks really target a certain level, then we should obtain a significantly positive speed of adjustment, one that is high enough to be consistent with mean-reversion processes; the coefficient on the banks' characteristics should also significantly differ from zero.

Our measure of the dependent variable, leverage, is given by the ratio between the book value of total assets and the book value of equity for the reasons seen in Section 2. The independent variables include a set of firm characteristics that appear regularly in the literature and that relate to different aspects of banks, such as size, profitability, stability, dividend policy, growth opportunities and risk. The following is the list of independent variables included in our regression specification:

Tier1 / Rwa is the ratio between the Tier 1 and the risk-weighted assets. This ratio is considered the main indicator of the bank's solidity; the regulator specifically requires that banks' Tier1/Rwa be higher than 6 percent, but most banks target higher values. Tier1 is a measure of capital that includes common equity and other capital related voices; risk-weighted asset is the sum of all assets weighted for the relevant risk measure as directed by the regulator. Therefore, a higher ratio indicates better-capitalised banks. An increase in the risk-weighted asset position for a given Tier1 should imply a reduction in leverage at least when capital requirement binds.

MTBV is the market-to-book value of the assets. A higher MTBV is generally taken as a sign of more attractive future growth opportunities; on the one hand, a high market-to-book ratio should allow the bank to sustain a higher level of leverage, as future returns are able to cover the cost of a high leverage; on the other hand, a high market-to-book also implies a valuable charter, which the bank might want to defend with a lower leverage ratio (hence a lower probability of default).

ln Ta: Represents the continuous natural log of total assets. The size of a bank can be positively related with its leverage for many reasons; a larger bank can benefit more from scale economies in managing risk, improved diversification, a greater ability to raise capital on short notice and also an increase in the "too-big-to-fail" put option.

Nl / Ta is the ratio between net loans and total asset. This represents an index of the bank's exposition to credit risk. Leverage could be negatively related to credit risk because this increases maturity mismatch and hence the liquidity risk of the bank. Banks with a greater portion of market portfolios over total assets are subject to a lower liquidity risk (as long as there is a functioning market) and should be able to have higher leverage.

Salary / Ta: Total salary and benefit compensation over total assets. If the salary is consistent with the managers' intrinsic ability, then a higher salary pool is related to higher-quality human capital; on the other side, a lower ratio may well indicate a more efficient structure.

Intexp / LtDebt: This is the ratio between interest charges on debt over long-term debt; it should be representative of the book-value cost of long-term debt. If leverage is independent of this ratio, it means that the market perceives that banks have the same probability of default.

Ni / Nl: Is the ratio between net income and net loans and represent an index of the loans' profitability.

NPLS / Nl: It is a measure of banks' asset risk position; a higher fraction of non-performing loans over total loans leads to a higher credit risk that the bank faces.

RWA / Ta: Risk-weighted assets over total assets. This is a measure of the riskiness of the investments. Risk-weighted assets are the sum of all of the banks' risky investment positions; this position is determined by the size of the investment and by the level of risk undertaken. When we divide the total risk position by the size of investment, we obtain a weighted average of the exposure to risk.

Our *GoB* variable is the instrument of banks' quality, and its identification varies in terms of the approach used; in the ex-ante approach, it takes the form of the ratio between EBIT and total assets. A higher value of this ratio indicates a bank with better asset quality. A test of our signalling hypothesis, that better-quality banks reveal themselves through a lower leverage ratio, will be based on a test of the coefficient of this variable; the signalling hypothesis is satisfied when this coefficient is negative.

In the other regression, based on what we call the ex-post approach, banks' quality is proxied by a dummy variable that takes the value of zero if the banks did not default or required government assistance and one in the opposite case. When a signalling hypothesis is satisfied, we should be able to observe a positive relation between leverage and our dummy variable, as a higher value of the dummy implies lower quality, and lower quality should imply higher leverage.

3.4.1 Estimation results

The inclusion of the lagged dependent variable in the regression makes the estimation process more difficult, as we need to handle a dynamic panel data. The main problem arising in dynamic panel data is that the lagged dependent variable can be correlated with the error term: The correlation creates a large-sample bias in the estimate of the coefficient of the lagged variable. If the regressors are also correlated with the lagged dependent variable, as they are here, their coefficients may be seriously biased as well.

A solution to this problem involves taking first differences of the original model. The first-difference transformation removes both the constant term and the individual effect. There remains a correlation between the lagged variable and the disturbance process (which now takes the form of MA(1)), but with individual fixed effects swept out, a straightforward IV estimator is available; we can construct the instrument from the second or third lag of the dependent variable. We use the more efficient DPD approach of Arellano and Bond (1991) to estimate our model. The Arellano-Bond estimator begins by specifying the model as a system of equations, one per period, and allows the instruments applicable to each equation to differ. The instruments include suitable lags of the levels of the endogenous variables as well as the strictly exogenous regressors. Table 3.2 reports the estimates of the regression based on the ex-ante approach, for both groups of banks considered (American and European).

The regression run on the US sample of banks gives good results in terms of significance; all of the coefficients associated with the banks' characteristics are statistically significant. We note that the coefficient on the lag value of leverage, $(1 - \lambda)$, is 0.4; this in turn implies that the speed of adjustment is 0.59, a much higher speed than that found for non-financial companies. This might reflect the fact that banks are better able to adjust their balance sheet, as they hold more tradable assets. The size of the assets has a positive implication on leverage, supporting the idea that larger banks are better able to diversify their portfolios. Consistent with Morris and Shin's (2008) findings, we get a negative relation between leverage and risk-weighted asset over total assets: when risk increases, leverage decreases. This can be generated by the internal risk management tools based on value at risk, whose main prescription is to reduce exposition when market volatility increases. Finally, we obtained a negative and very significant coefficient for our proxy of banks' quality: a high return on assets is associated with low leverage. This fact is consistent with our signaling framework.

The results for the European panel differ in some aspects but remain unchanged in the variables relevant for our test of signaling. Here again, we have a high speed of adjustment, although lower than for US banks, of 0.4. This can be the result of a less liquid market in Europe than in US that in turns increase the frictions to changes in leverage for European banks. The risk weighted asset to total asset ratio is again negatively related to leverage; most importantly changes in return on assets imply negative changes in leverage. So, also for this panel data, the test gives a positive result for our signaling theory.

In Table 3 we report the result obtained by running the same econometric model on the mixed sample of failed/assisted and non failed US financial institutions. We note that the mean leverage ratio of the second sample is already slightly higher from that of the first sample. Just as a reminder, the first sample contains the 40th biggest US banks in term of market cap, while the second contains all those US banks (failed or alive) with total assets higher than 30 billion dollars; the two groups largely coincide except for the inclusion of the failed banks in the second list.

3.5 Summary and Conclusions

We developed a double test for the signaling effect of banks' capital structure; we assume, indeed, the existence of a signaling equilibrium in the market, under which better quality banks reveal their intrinsic characteristic to the market through a lower leverage ratio.

We employed two different methods to test the relation between quality and leverage; since quality is an unobservable variable, we instrumented it in two different ways: in the first one, we assumed that assets quality reflects in the average return on the assets (coherently with the ex-ante realization of returns); better quality banks are those with higher returns on assets; we found a positive relation between ROA and leverage holding both for US and European Banks. In the second approach, we assumed that failed banks were those with lower asset quality. We run the regression of leverage on a dummy variable for default and other control variables. Again, we found that leverage is positively related with default.

We then proved there exist a negative relation between leverage and asset quality and we interpret the results on the basis of a signaling model.

.1 US GAAP versus IFRS

In this appendix, we expose the critical differences between the accounting standards adopted by banks in the United States and across Europe. The difference in standards implies a significant difference in the quantification of the balance sheet variables, which renders impossible an empirical analysis on a cross-country sample of banks. IFRS and US GAAP provide different principles for the recognition, classification and quantification of bank assets and liabilities; all of these variables enormously impact the identification of the banks' leverage.

Although IFRS and U.S. GAAP are similar in many ways and both the legislative authorities, the IASB and FASB, are committed to convergence, several differences remain for financial institutions. The major differences relate to the classification and measurement of certain financial instruments, their recognition or de-recognition from the balance sheets and the consolidation criteria. In general, American banks' reported leverage is substantially inferior to that of their European rivals, as they are allowed to retain more assets off their balance sheets. IFRS are indeed generally more stringent with regard to consolidation principles, the de-recognition of financial assets and guidance covering the offsetting assets and liabilities under master netting arrangements. Consequentially, European banks report more assets on their balance sheets, thus accounting for a higher leverage ratio than their American counterparts.

In this paragraph, we want to provide an overview of some of the most significant differences between U.S. GAAP and IFRS [4]; by no means, however, is this an all-encompassing study of the accounting standards.

1. <u>Principle of Consolidation:</u> Under the U.S. GAAP, the principles for consolidation are based on a two-tiered model: initially, all entities are evaluated under the Variable Interest Entities model; those entities that are reconsidered to follow inside the category of VIEs are then consolidated on the basis of an effective economic control. Residually, all the entities that are not classified as VIEs are consolidated under the voting interest model.

   A variable-interest entity (VIE) is defined as a business structure that allows an investor to hold a controlling interest in the entity, without that interest translating into possessing enough voting privileges to result in a majority; variable-interest entities are generally thinly capitalised entities and include many special-purpose entities or "SPEs". The consolidation of VIE is based on a quantitative analysis of the economic conditions between the parties: consolidation is due

[4] This paragraph is based on PricewaterhouseCoopers and Ernst Young's guidelines on the adoption of IFRS; we also retrieved useful information from the Notes to consolidated financial statements of Deutsche Bank and Bank of America

when the parent company has the right to receive expected residual returns or retains exposure to expected losses. As an exception, a special group of VIE that qualify as QVIE (Qualified Variable Interest Entities) are not consolidated on the balance sheet. All the other entities, non-VIE, are instead evaluated under the voting interest model: Control is then presumed any time the parent company holds 50 percent or more of the voting shares (based on the actual voting rights in circulation) or less than 50 percent but in the presence of an effective control that is contractually designed.

European IFRS, with IAS 27, also focuses on the concept of control in determining whether a parent-subsidiary relationship exists, but control is here defined as the parent's ability to govern the financial and operating policy of a subsidiary to obtain benefits. Control is therefore presumed when the parent retains 50 percent of the voting powers in the subsidiary, including potential voting; at the same time, control exists when a parent owns half or less of the voting power but has legal or contractual rights to control. In rare circumstances de-facto control is also considered (for example, when a major shareholder holds an investment in an entity with an otherwise dispersed share holdings).

Special consolidation rules apply to the special interest entities (SPE). A SPE is a legal entity created to fulfil narrow, specific or temporary objectives. SPEs are typically used by companies to isolate the firm from financial risk. A company will transfer assets to the SPE for management or use the SPE to finance a large project, thereby achieving a narrow set of goals without putting the entire firm at risk. SPEs are commonly used to securitise loans (or other receivables). For example, a bank may wish to issue a mortgage-backed security whose payments come from a pool of loans. However, to ensure that the holders of the mortgage-back securities have the first priority right to receive payments on the loans, these loans need to be legally separated from the other obligations of the bank. This is done by creating an SPE, and then transferring the loans from the bank to the SPE. SIC 12 addresses when a special purpose entity should be consolidated by a reporting enterprise under the consolidation principles in IAS 27. Under SIC 12, an entity must consolidate a special purpose entity ("SPE"): when, in substance, the entity controls the SPE.[5] Control of an SPE is presumed in three circumstances: when the SPE conducts activity on behalf of the evaluating entity, when the parent holds the decision-making power to obtain the majority of benefits, and finally when the majority of the residual or ownership risks of the SPE or its asset is retained.

In conclusion, although IFRS and U.S. GAAP differ in the application of the voting rights model, the main discrepancy among the two is based on the different treatment for VIEs and SPEs. SIC 12 indeed proposes a consolidation of all those

[5]http://www.iasplus.com/interps/sic012.htm

entities that are substantially controlled by the parent company, whereas under FIN 46(R) consolidation, the requirements focus on whether an entity is a VIE regardless of whether it would be considered an SPE (in particular, some SPEs are recollected in the QVIE and non-consolidated). Due to the significance of the SPEsÕ activity in securitisations and the greater potential impact of the two standards on the banks' accounts, the FASB has released a proposal, which should soon be finalised as principles, to revise the criteria for the consolidation of VIEs[6]. The new standard now requires a company to perform a qualitative analysis when determining whether it must consolidate a variable-interest entity. Under the standard, the evaluation of control in a more substantial fashion is required: If the company has an interest in a variable-interest entity that provides it with control over the most significant activities of the entity (and the right to receive benefits or the obligation to absorb losses), the company must consolidate the variable-interest entity. The exception for QVIEs is also eliminated.

The 2007-2008 subprime crisis has underlined the defiance of the consolidation principles and highlighted the need for a reform. It is now indeed clear that banks attempted to exploit capital requirement arbitrage by availing themselves of a credit risk-transfer mechanism for the unique purpose of increasing their effective leverage. Those mechanisms, per se, have the function of transferring credit risk onto other investors in the economy. However, their actual implementation was intended to reduce capital requirements while maintaining de-facto control of the credit risk: Effectively all conduits had recourse to the bank balance sheet even if banks contractually provided uniquely liquidity enhancement and credit enhancement to the conduits. Although under IFRS, most of the conduits were consolidated on the balance sheet, the opposite was true in that US. This implied that, when the crises erupted and the banks' insurance became clear, many of these conduits had to be reported back on the balance sheet, causing an important deterioration in capital ratios[7].

2. Asset De-recognition:Differences in the rules regarding asset de-recognition can have a significant impact on a variety of financial transaction such as asset securitisation. While U.S. GAAP focuses on whether the entity has surrendered control over the asset, IFRS requires a qualifying transaction that basically transfers all risk and rewards connected with the assets. Because in most of the securitisations the transferor maintains an involvement with the transferred asset, either in the form of guarantees or repurchasing agreement, they would not qualify for de-recognition under IFRS.

   FAS 140, the main principle for asset de-recognition under U.S. GAAP, requires the transferor to evaluate whether there had been a transfer of control over the

[6] http://www.macpa.org/Content/24998.aspx

[7] See Acharia V, Richardson M., 2009 for a full discussion of this issue.

assets. The transfer of control is achieved when there is a legal isolation of the transferred asset from the transferor, when the transferee has the ability to pledge or exchange the assets and finally when the transferor maintains no right or obligation to repurchase the assets. Therefore, de-recognition can be achieved even if the transferor has significant ongoing involvement with the assets, such as a significant retention of credit risk.

On the other side, the IFRS guidance IAS 39 focuses on the evaluation of whether a qualifying transfer took place and risks and rewards relating to the assets had been transferred. De-recognition takes place after consolidation guidelines are applied: first, all the controlled SPEs are consolidated, then full de-recognition is appropriate if two conditions are met. The conditions require the financial asset to be transferred outside the boundaries of the group and that all substantial risks and rewards have been transferred. On the contrary, FAS 140 is applied before consolidation: if the transfer took place trough a SPE that meets the definition of QSPE, the assets can be derecognised, and the QSPE is then not consolidated[8].

Finally, IAS 39 considers the possibility of a "partial de-recognition" for those assets whose related risks and returns have not been substantially transferred or retained (and the transferee is not able to unilaterally sell the asset). Under partial de-recognition, the entity must continue to recognise the transferred asset to the extent of its exposure to changes in the value of the asset. The exposure is measured as either the maximum amount of consideration received that the entity could be required to repay (in the case of guarantees) or the amount of the transferred asset that the entity may repurchase (in the case of a repurchase option). Under U.S. GAAP, instead, there is no concept of "partial de-recognition": when a transaction qualifies for de-recognition, the transferor must recognise any retained ongoing liability at fair value. The fair value of a guarantee would reflect the likelihood of payment or repurchase rather than the maximum possible payment.

3. <u>Offsetting of assets and liabilities:</u> Differences in the guidance covering the offsetting of assets and liabilities under master netting arrangements, repurchase and reverse repurchase agreements could change the representation of items currently shown as net or gross under U.S. GAAP; in particular, more items are likely to appear as gross under IFRS, giving a positive contribution in the increase in asset size.

   When different transactions are undertaken with a single counterpart, the entities can enter a master netting agreement; this agreement provides for a single net

[8] Changes in consolidation rules currently at study propose the elimination of the qualified special purpose entities. This might change the ability to derecognise securitised assets also under U.S. GAAP.

settlement of all financial instruments that can occur between the two counterparts in the event of default or on termination of any of the contracts. A master setting agreement commonly creates a right to set off that becomes enforceable and affects the realisation of settlements only following a specified event of default or following other circumstances not expected to arise in the normal course of business.

Under U.S. GAAP, the offsetting of assets and liability (i.e., reporting on a net basis) is generally improper except when a right to set off exists. The right to set off is defined as a debtor's legal right to discharge all or a portion of a debt owed to another party by applying against the debt an amount that the other party owes to the debtor. This right exists when it is enforceable by law, each of the two parties owns the other a determinable amount, the reporting party has the right to set off the amounts and that party intends to do it. Special guidelines are drawn for derivatives designed under master setting arrangements. In this case, an entity may offset fair-value amounts recognised for the derivative instruments, with the fair-value amounts recognised for the right to reclaim cash collateral arising from the derivative instrument itself.

On the other side, under IFRS the reporting party's intention to set off is not sufficient for reporting on a net basis. More precisely, two conditions need to hold to present a net amount on the balance sheet: The entity must currently have a legally enforceable right to set off and intends either to settle on a net basis or to realise the asset and settle the liability simultaneously. The requirement of contextual settling is therefore stronger than the pure intention to set off. Finally, master netting arrangements do not provide a basis for offsetting unless both the previous criteria are satisfied.

4. <u>Classification and Measurement:</u> Under US GAAP, various specialised pronouncements provide guidance for the classification of financial assets. IFRS has only one standard for the classification of financial assets and requires that financial assets be classified in one of four categories: assets held for trading or carried at fair value, with changes in fair value reported in earnings; held-to-maturity investments; available-for-sale financial assets; and loans and receivables. The specialised US guidance and the singular IFRS guidance in relation to classification are particularly important because they can drive differences in both classification and measurement (because classification drives measurement under both IFRS and US GAAP).

   Loans represent the most traditional form of investment for bank. Under this category are all the borrowings to clients for which the bank retains the associated credit risk. Although the loan activity is the foundation of banksÕ existence, loans and receivables may be carried at different amounts under the two frameworks. The definition of loans and receivables is different for the two standards:

Under U.S. GAAP, loans are a residual category of fixed-income instruments that do not comply with the definition of a debt security. A debt security, under FAS 115, is an asset commonly available on securities exchanges or in markets or, when represented by an instrument, is commonly recognised in any area in which it is issued or dealt in as a medium for investment; a debt security is classified as either trading and held for sale and accounted for at the lower between fair value and cost. Under IFRS, loans and receivables are financial assets with fixed or determinable payments not quoted in an active market, other than those the entity intends to sell in near term or has initially recognised as available for sale. Instruments that meet this definition are carried at amortised cost; all the other debt instruments are carried at fair value. IFRS does not have a category of loans and receivables that is carried at the lower of cost or market.

The main differences relating to the category of assets classified as available-for-sale concern the treatment of unlisted equity securities and the foreign exchange gain component of the variation in debt securitiesÕ fair value. Unlisted equity is generally scoped out of FAS 155 and therefore carried at cost; under IFRS, all assets, including unlisted equity securities, are measured at fair value. On the other side, the treatment of foreign exchange gains and losses on available-for-sale debt securities will create more income-statement volatility under IFRS.

5. Derivatives and Hedging: Derivatives and hedging represent one of the more complex and nuanced topical areas within both US GAAP and IFRS. While IFRS is generally viewed as less rules-laden than US GAAP, the difference is less dramatic in relation to derivatives and hedging, wherein both frameworks embody a significant volume of detailed implementation guidance. Although the hedging models under IFRS and US GAAP are founded on similar principles, there are a number of differences in their application. Some of the differences result in IFRS being more restrictive than US GAAP, whereas other differences provide more flexibility under IFRS.

   Hedge accounting is a particular tool established by the authorities to reduce the volatility in profit and loss due to different measurement standards for hedged assets and liabilities. Both the mentioned standards require derivatives to be accounted for at fair value, with changes in fair value reported in the profit and loss. On the other side, some assets and liabilities, such as assets held to maturity, loans and receivables and financial liabilities not held for trading, are accounted for at amortised cost. When a bank enters a derivative contract to hedge an asset evaluated at fair value, no other modifications are needed, as both the change in fair value of the asset would compensate the change in fair value of the derivative in the profit and loss account. When, instead, the derivative hedges an asset accounted for at cost, only the change value of the derivative would appear on the profit and loss account. To alleviate this measurement mismatch, bank can adopt hedge accounting. In general, hedge accounting consents either to revaluate the asset recorded at cost (to the extent that the revaluation reflects the hedged risk), with the revaluation transiting into the profit and loss account, therefore offsetting changes in the fair value of the derivative, or to exclude changes in the value of the hedge from the profit and loss so that, again, the net effect on income is cancelled out.

Areas where IFRS is more restrictive than US GAAP include the nature, frequency and methods of measuring and assessing the effectiveness of a hedge. Another area where IFRS is more restrictive involves the use of basis swaps as hedging instruments. The use of basis swaps is specifically addressed and permitted via tailored rules under US GAAP. No basis-swap-specific guidance exists under IFRS. While the use of basis swaps as hedging instruments is not included in principle under IFRS, in many cases, the general IFRS-based ineffectiveness will be so great as to disqualify an entity from using hedge accounting. IFRS is also more restrictive than US GAAP in relation to the use of internal derivatives. Restrictions under the IFRS guidance may necessitate that entities desiring hedge accounting enter into separate, third-party hedging instruments for the gross amount of foreign currency exposures in a single currency, rather than on a net basis (as is done by many treasury centres under US GAAP).

At the same time, there are a number of areas where IFRS provides opportunities not available under US GAAP. Such opportunities arise in a series of areas where hedge accounting can be accomplished under IFRS, whereas it would have been precluded under US GAAP. For example, under IFRS an entity can achieve hedge accounting in relation to the foreign currency risk associated with a firmÕs commitment to acquire a business in a business combination (whereas US GAAP would not permit hedge accounting). At the same time, IFRS allows an entity to utilise a single hedging instrument to hedge more than one risk in two or more hedged items. This difference may allow entities under IFRS to adopt new and sometimes more complex risk management strategies while still achieving hedge accounting. IFRS is more flexible than US GAAP with respect to the ability to achieve fair-value hedge accounting in relation to interest rate risk within a portfolio of dissimilar financial assets and in relation to hedging a portion of a specified risk and/or a portion of a time period to maturity (i.e., partial-term hedging) of a given instrument to be hedged. A series of further differences also exist.

Table 3.1: Summary Statistics: US banks

	Number of Observation	Mean	St Dev	Min	Max
Leverage	2369	11.53422	2.682942	3.049174	27.31548
Tier1_Rwa	912	0.118434	0.063459	0.04027	0.75915
Ebit_Ta	2285	0.022854	0.009369	-0.04032	0.065249
lnTa	2369	16.79237	1.570726	12.30507	21.22949
Npls_Nl	2267	0.007717	0.005945	0	0.056682
Intexp_LtDebt	1836	1.576692	14.30932	0.003956	234.3793
Salary_Ta	2365	0.016618	0.006466	0.002351	0.045854
Rwa_Ta	912	0.736741	0.171336	0.090835	1.299824
Ni_Nl	2357	0.054828	0.016412	-0.12091	0.139038
Mtbv	2323	2.099281	0.930059	0.2	8.54
Nl_Ta	2357	0.616227	0.119721	0.234755	0.873102

Table 3.2: Summary Statistics: EU banks

	Number of Observation	Mean	St Dev	Min	Max
Leverage	2266	23.77286	12.39345	4.754514	165.2265
Tier1_Rwa	1109	0.086981	0.027109	0.050126	0.355408
Ebit_Ta	1970	0.020517	0.015588	-0.03662	0.113331
ln_Ta	2266	18.6792	1.445883	12.72798	21.9051
Npls_Nl	1555	0.024624	0.041442	0.000236	0.430861
IntExp_LtDebt	1376	7.859051	61.38698	-7.21843	863.8571
Salary_Ta	2206	0.011371	0.00515	0.002816	0.036861
Rwa_Ta	1121	0.498509	0.186488	0.124215	0.933799
Ni_Nl	2226	0.043139	0.0567	-0.02017	0.555674
Mtbv	2100	1.906795	0.940865	0.03	6.62
Nl_Ta	2238	0.597302	0.152255	0.109401	0.876857

Table 3.3: Summary Statistics: US failed and non failed banks with total asset higher than 30 billions dollar

	Obs	Mean	Std. Dev.	Min	Max
Tier1 / RWA	632	.1013209	.0571446	.0406289	.7612627
ln Trading Assets	1092	1.253.048	2.673.219	5.484.797	2.004.989
STborrowing / Ta	1640	1492613	.0900152	.0042228	.6430299
Ni / Nl	1540	.0223219	.0285201	-.1753192	.2467785
ln Ta	1640	1.777.479	1.327.527	1.429.889	2.150.032
Salaries / Ta	1640	.0187404	.0076245	.0038657	.0584984
Dep /TotalDebt	1540	3.846.292	349.871	.0565292	5.147.497
NL /TL	1540	.9823499	.0082012	.9382487	.9988609
NPLS / NL	1472	.0100966	.011456	0	.1013879
Ebit / Ta	1552	.0207493	.0124212	-.0688447	.0922008
Rwa / Ta	632	.8147196	.1673017	.0905828	1.215.255
Leverage	1640	12.978	407.227	5.933.747	3.465.175
MTBV	1609	2.210.653	108.683	.09	8.28
DPS	1563	.8304734	.5995561	.04	3.08

Table 3.4: Regression Results: US banks

AB DPD estimation — Number of obs= 680
Group variable: banks — Number of groups = 39
Time variable: qdate
Obs per group: min = 3
avg = 17.4359
max = 26

Number of instruments = 360 Wald chi2(13) = 2480.45
Prob chi2 = 0.0000

leverage	Coef.	Std. Err.	z	P¿z	[95% Conf.	Interval]
L1.	0.415533	0.0277068	15	0	0.3612287	0.4698373
l_ Leverage						
L1.	0.0238753	0.0322196	0.74	0.459	-0.0392739	0.0870246
L2.	-0.0356699	0.026907	-1.33	0.185	-0.0884067	0.0170668
Mtbv	0.4062642	0.0729249	5.57	0	0.263334	0.5491944
Tier1_Rwa	-9.726488	1.290787	-7.54	0	-12.25638	-7.196592
Ebit_Ta	-42.98209	4.036232	-10.65	0	-50.89296	-35.07122
ln_ Ta	1.387979	0.2289006	6.06	0	0.9393426	1.836616
Nl_Ta	-3.046069	1.038157	-2.93	0.003	-5.08082	-1.011318
Npls_Nl	36.16542	5.608896	6.45	0	25.17218	47.15865
Intexp_LtDebt	-0.0027346	0.0016873	-1.62	0.105	-0.0060416	0.0005724
Salary_Ta	-88.05008	14.33429	-6.14	0	-116.1448	-59.95538
Rwa_Ta	-2.466656	0.5588323	-4.41	0	-3.561947	-1.371364
Ni_Nl	-11.00846	7.78697	-1.41	0.157	-26.27064	4.253715
_ cons	-10.94222	4.441489	-2.46	0.014	-19.64738	-2.237066

Table 3.5: Regression Results: EU banks

AB DPD estimation — Number of obs= 680
Group variable: banks — Number of groups = 39
Time variable: qdate
Obs per group: min = 3
avg = 17.4359
max = 26

Number of instruments = 360 — Wald chi2(13) = 2480.45
Prob chi2 = 0.0000

Leverage	Coef.	Std. Err.	z	P¿z	[95% Conf.	Interval]
L1.	0.5959561	0.031479	18.93	0	0.534259	0.657654
l_Leverage						
L1.	0.0788861	0.038623	2.04	0.041	0.003186	0.154586
L2.	0.1364097	0.036364	3.75	0	0.065138	0.207682
Mtbv	7.591879	0.429576	17.67	0	6.749925	8.433832
Tier1_Rwa	85.81749	27.7936	3.09	0.002	31.34304	140.2919
Ebit_Ta	-467.394	48.31138	-9.67	0	-562.083	-372.705
ln_Ta	6.156132	1.562441	3.94	0	3.093804	9.21846
Nl_Ta	53.74658	5.293561	10.15	0	43.37139	64.12177
Npls_nl	-29.05315	42.23987	-0.69	0.492	-111.842	53.73548
Intexp_LtDebt	-0.0131488	0.002751	-4.78	0	-0.01854	-0.00776
Salary_Ta	-1023.269	245.9862	-4.16	0	-1505.39	-541.145
Rwa_Ta	-11.36065	7.571071	-1.5	0.133	-26.1997	3.478375
Ni_Nl	241.5765	34.88067	6.93	0	173.2116	309.9413
_ cons	-149.7281	34.82556	-4.3	0	-217.985	-81.4713

Table 3.6: Regression Results: US failed and non failed banks

Random effects u_i Gaussian	Wald chi2(15)	=	158.61
corr(u_i, X) = 0 (assumed)	Prob chi2	=	0.0000

Leverage	Coef.	Std. Err.	z	P z	[95% Conf.	Interval]
Rwa / Ta	-.9761953	143.479	-0.68	0.496	-3.788.332	1.835.941
Leveragelag	.0122163	.0153023	0.80	0.425	-.0177756	.0422083
Tier1 / RWA	-.721813	2.056.747	-0.35	0.726	-4.752.964	3.309.338
ln Trading assets	.2148082	.1059936	2.03	0.043	.0070646	.4225517
Ni Nl	-4.009.634	3.034.581	-1.32	0.186	-9.957.303	1.938.036
STborr Ta	1.441.132	2.795.791	5.15	0.000	8.931.675	1.989.097
ln Ta	-1.022.514	.2724813	-3.75	0.000	-1.556.568	-.4884608
salaries / Ta	-6.336.184	2.950.661	-2.15	0.032	-1.211.937	
Dep / TD	.1493175	.0742255	2.01	0.044	.0038382	.2947969
NL / TL	-7.190.404	2.134.374	-3.37	0.001	-113.737	
NPLS / NL	-1.350.449	1.252.726	-1.08	0.281	-3.805.748	1.104.849
Ebit / Ta	-3.850.218	1.066.838	-3.61	0.000	-5.941.182	
MTBV	.304291	.1248462	2.44	0.015	.059597	.548985
DPS	1.214.558	.2209649	5.50	0.000	.7814746	1.647.641
GOB	.5944125	.9360964	0.63	0.010	-1.240.303	2.429.128
cons	9.701.242	2.306.967	4.21	0.000	5.179.671	1.422.281

sigma u	1.434.865			
sigma e	17.305.739			
rho	.40739019	(fraction	of variance due	to u_i)

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