Is there a case for maturity mismatch and capital ratios as complementary measures to identify risky banks and trigger for supervisory intervention?

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Abstract

Evidently, banks face a liquidity due to their fundamental role in maturity transformation. But, in recent years, market evolution and financial innovation have modified banks' practices and, consequently, the nature of liquidity risk. The main consequence of these various modifications is the increased connection between banking activities and markets. Hence, liquidity has become an important contagion channel for systemic risk.

The regulatory consequence (of these changes) is that a regulation of banks based only on capital adequacy as it is today seems to be depleted. Complementing capital adequacy ratios with a liquidity risk indicator to trigger supervisors' intervention can be one alternative .

To use of the liquidity risk measure as additional information to detect high risk banks, we compare the accuracy of capital ratios and liquidity risk indicator, the maturity mismatch ratio in order to identify severely troubled institutions in a timely manner. We first studied a selection of European banks in a statistical methodology to compare the two measures efficiency to identify risky banks. Then,we perform logit regressions to validate our results. Finally, we measure and compare the Accuracy Ratios of the two rating systems. The statistical results suggest that the maturity mismatch criterion tends to excessively classify banks as risky and that the MMR outperforms RBCR and LR to identify risky banks. Consequently, the statistical results are consistent with what we were expecting .

The logit model confirm the results previously obtained by the statistical analysis. This demonstrates that the maturity mismatch ratio we have constructed, even if it is a simple measure correctly reflects banks' liquidity risk. Consequently, it can be used as a PCA trigger : simplicity is one of the features required for PCA triggers. These results suggest that the modification of banks' structure, which conveys to an increased dependency to market liquidity has to be considered in the new European regulatory framework.

Comparing the Accuracy Ratios across two different model classifications shows that the classification with the PCA classification we propose yields a largest Accuracy ratio than the classification with current PCA triggers. However, the degree of improvement is rather small. Therefore, it cannot allow us to conclude with certainty that the classification we propose is better than the existing one.

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1. Introduction

Banks face naturally a liquidity risk relative to their fundamental role in maturity transformation. But, in recent years, market evolution and financial innovation have modified the nature of that risk. We can for example, mention the widespread use of securitisation and complex debt instruments as Collateralised Debt Obligations, the increasing use of market funding, but also the fact that many banks lend directly to highly leveraged institutions like hedge funds. One of the main reasons mentioned to justify these new practices was the desire to reduce dependency on deposit-based funding. These new practices have changed the nature of banks' balance sheet on asset and liability sides. They have also modified their funding structure which, is more exposed to market volatility and anticipations. These alterations resulted in an increased connection between banking activities and markets. Therefore, liquidity has become an important contagion channel for systemic risk.

As consequence of these changes in banking activities, the regulation of banks,focusing only on capital adequacy as it is today, seems to be depleted.

To trigger supervisors' intervention, it would be interesting to complement capital adequacy ratios with another source of information as an alternative.

A first trail has been to introduce market based information in addition to capital ratios. But, this solution encountered a strong opposition mainly due to difficulties to obtain high quality market data providing clear signal to supervisors. A second trail could be to add up a liquidity risk indicator to trigger a supervisory intervention. Indeed, the 2007 crisis perfectly illustrated that the borderline between illiquidity and insolvency for a bank was more and more blurred as consequence of banks' new practices. So, banks which faced more difficulties were the more vulnerable to the market liquidity.

The early detection of risky banks is to the construction of the new European regulatory framework because the current crisis has demonstrated that banking problems can emerge really quickly and lead to a systemic crisis. Early detection of individual bank's difficulties should reduce the probability of a failure and the risk of contagion.

In this paper we are not trying to obtain a perfect measure of liquidity risk. We are only trying to obtain a simple representative measure of this risk in order to emphasize the importance of liquidity risk in the assessment of banks risk today. As the impact of the liquidity shock on banks depends on their degree of reliability to wholesale funding, we choose to focus on the estimation of maturity mismatches concerns.

To estimate the need of the of the liquidity risk measure to detect high risk banks, we compare the accuracy of capital ratios and maturity mismatch ratio to identify severely troubled institutions in a timely manner. We first study a sample of European banks with a purely statistical comparison of the two measures accuracy in the identification of risky banks. Then, we perform logit regressions to validate our results. Finally, we measure and compare the Accuracy Ratios of Prompt Corrective Action (PCA) on one hand and the new mixed rating systems on the other hand.

The statistical results suggest that the maturity mismatch criterion outperforms the risk-based capital ratio and leverage ratio in the identification of risky banks. The logit model results confirm the results previously obtained by the statistical analysis. This demonstrates that the maturity mismatch ratio, as simple as it is, can be used as a PCA. Comparing the Accuracy Ratios across the two different rating models shows that the new classification yields a larger Accuracy ratio than the current PCA classification. However, the degree of improvement is minimal. Therefore, it cannot lead us to conclude with certainty that the classification we are suggesting is better than the existing one.

In the second section of this paper, we will highlight the increasing relation between market liquidity and banking liquidity and, the challenges emerging from these new relationships. The third section will comtemplate adequate triggers for the European PCA. Finally, the fourth and last section will present the empirical findings.

2. Market liquidity and banking liquidity

2.1. The emergence of new practices in banking activity

Banks face naturally a liquidity risk because of their fundamental role in maturity transformation. This liquidity risk may have many origins and is linked to uncertainty. Regarding the liabilities side, uncertainty arises from deposits withdrawals and interbank loans' renewal. When we consider the assets side, uncertainty comes from the new and renewal amount of loans. Off balance sheet activities and participation to RTGS (Real Time Gross Systems) payment systems also represent sources of liquidity risk.

But, in recent years, market evolution and financial innovation have modified the nature of liquidity risk. Indeed, contemporary markets characteristics generate new challenges in banks liquidity monitoring. We can for example mention the widespread use of securitisation and complex debt instrument as Collateralised Debt Obligations (CDOs). Banks are nowadays amongst the major issuers of securities and participants to securitized products markets. The issuance of securitized assets grew almost six folds in Europe between 2000 and 2006 (Praet and Herzberg 2008). In Europe, covered bonds outstanding increased by 22.7% between 2003 and 2007 (ECB, 2009). Their importance in these markets can be explained by the fact that some banks increasingly rely on capital market funding. In 2003, deposits represented around 42.4% of banks total liabilities and capital market funding was around 27%. In 2007, these

figures were respectively around 39.3% and 26.6%. In Europe, money market funding which represented around 11.8% in 2003 grew until 16% in 2007.

Another transformation is banks increasing use of derivatives to manage their funding risks and interbank transactions.Bank lending has also changed. Many banks lend directly to highly leveraged institutions like hedge funds in addition to retail lending. The particularity of this new form of lending is that it is collateralized. A rapid growth in banks' off balance sheet activities represents another major change. Off balance sheet vehicles offer the parent bank both short and long term sources of funding. The first one is given through asset-backed commercial paper and the latter through securitization (ECB, 2009).

2.2. The increasing interconnection between banks and markets

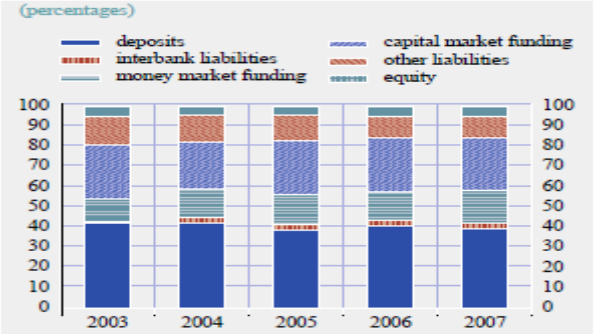
These new practices have changed the nature of banks' balance sheet and funding structure which are more exposed to market volatility and to anticipations. It resulted in an increased connection between banking activities and markets.

On the asset side, many sources of vulnerability have appeared. Securitization of loans represents a source of cash for banks. The occurrence of a liquidity squeeze in structured assets markets can induce pressure on banks' earnings and lead to an increase in capital requirements.

The increasing complexity of financial instruments has arisen the demand for collaterals which induces additional pressures on liquidity coming from margin calls. This higher complexity also feeds on the lack of transparency that may contribute to market freezing during stress periods. Furthermore, the value of structured assets used by banks ,as buffers against liquidity shocks, depends on market liquidity conditions which can vary across issuing and secondary market and across time periods.

The increasing use of market-based funding has raised maturity mismatches in banks' balance sheets which exposes them to an higher funding and counterparty risk (see graph 1).

Graph 1: European banks liabilities (overall structure)



Source: Bankscope

Market liquidity can be subject to sudden frictions due to an asymmetric information is essential in these markets. During stress periods, even a solvent bank can be prevented from covering its liquidity needs. This raises systemic risk (Huang and Ratnovski).

On the liability side, we also observe new vulnerabilities. The broadening of the range of acceptable collateral in secured borrowing, especially as more complex and less liquid securities has widened banks' vulnerability to market liquidity shocks (Praet and Herzberg, 2008). In the case of these particular assets, liquidity drying out can also induce valuation problems which contributes to freeze market liquidity. Indeed, valuation models and historic relations, used to estimate liquidity risk during normal periods, become obsolete during stress periods. During these stress periods, asset liquidity no longer depends on the asset characteristics but only on counterparts' behavior.

The growing relation between banks and other market participants, like hedge funds and broker dealers, also expose banks to liquidity shocks. These less regulated counterparts are particularly vulnerable to market shocks mainly because they are often highly leveraged.

Consequently banks will be affected by market shocks based on their collateralized exposure to these market participants.

Liquidity lines,given by banks to financial conduits, prevent the latter from liquidity risk in the case of market turbulences. These off balance sheet commitments represent an important potential source of cash outflows for banks because a shock on market liquidity can trigger the activation of banks liquidity lines (see graph 2).

Graph 2: European banks with some of the largest liquidity facilities to funding ratios

(liquidity facilities in USD billions; liquidity facilities/funding and Tier 1 ratio in %)

	Liquidity facilities	Liquidity facilities/ funding	Tier 1 ratio
Sachsen Landesbank	24.02	31.60	7.8
IKB Deutsche Industriebank	19.47	28.82	7.2
Hypo Real Estate Bank	17.95	8.70	6.9
Lloyds Bank Group	39.09	7.19	-
Bayerische Landesbank	27.65	6.58	11.0
Calyon	19.39	6.35	9.6
Dresdner Bank	37.77	6.23	10.4

Funding = deposits + senior and subordinated debt based on end 2006 and Q1 2007 numbers; liquidity facilities show maximum commitments.

Source: Citibank

During systemic crises, there is an interaction between dependency to liquidity and assets markets. This relation is illustrated by the fall of asset prices resulting from fire sales. Fire sales worsen the deterioration of bank balance sheets and lead to the evaporation of market liquidity making the debt reduction impossible. Furthermore, when a liquidity shock happens, market participants may have to adjust their portfolio because they face stop-loss levels and margin calls. Counterparties can also refuse to provide banks short term funding. So, a solvent bank can quickly become insolvent simply due to liquidity problems. With mark-to-market accounting, changes in asset prices rapidly impact the solvency of financial institutions. Hence, during stress periods a tightening in market liquidity quickly affects banks equity (Aglietta and Scialom, 2009). Thanks to banking liquidity externalities, market liquidity shocks have now the potential to quickly propagate to money and interbank markets which

can severely threaten financial stability. Indeed, the transmission between banks can pass through classical interbank links but also through the short term counterpart channel. In market finance, the fall of prices is a contagion channel as well as individual defaults. Consequently, liquidity has become an important contagion channel for systemic risk (Brunnermeir and Pedersen, 2006).

3. Which triggers for the European Prompt Corrective Action?

3.1. Early detection of failing banks

One of the main lessons of this crisis is that problems can emerge really quickly therefore supervisors must react very early. This question takes a particular importance in Europe where most banking institutions are too big to fail whereas banking regulation still ignores systemic risk and does not manage to deal with the failure of big institutions at the least cost. To reduce the resolution cost of the failure of big institutions, it is crucial for supervisors to react as early as possible to modify banks' behavior.

Since the 70s, consolidation in the banking industry has accelerated. The emergence of large and complex banking organisations ,which are by definition "too big to fail", raises some important questions. First their failure can have a systemic impact and be expensive for taxpayer. Second, their rescue by supervisory authorities can have a negative impact on the efficiency of the financial system because of moral hazard problems. Consequently the risk of regulatory capture and forbearance associated to these large and complex institutions is really high.

There is today a consensus between governments and international organisations on the importance to better take into account systemic risk in banking regulation and supervision.

Early detection of individual bank's difficulties should reduce the probability of a and consequently, the risk of contagion. But, the opacity of these institutions makes timely identification of difficulties at individual banks harder. Supervisors use different sort of qualitative and quantitative instruments to estimate the economic and financial characteristics of an individual institution and to detect risky banks. The most famous indicator of banking fragility is the CAMELS used by US supervisors since 1880. Since the 90s, European supervisors have also constructed Early Warning Systems following the US initiative. These systems are called ORAP in France, BAKIS in Germany, PATROL in Italy, RATE in Great Britain and, RATS in the Netherlands (Chauveau and Capelle Blancard). Even if they are useful tool for an accurate analysis of the risk at an individual bank, these systems need to be complemented by a more reactive mechanism. Their complexity, as a result of the number of information they take into account, limits their ability to allow supervisors to react as quickly as possible.

The implementation of a Prompt Corrective Action (PCA) mechanism in Europe as in the US can in our opinion fill this gap even if it requires some prerequisites. However, many academics agree on the idea that the introduction of PCA in Europe can be a valuable contribution to the existing ad hoc banking crises approach. The interest of PCA consists in early identifying banks' difficulties which, allow supervisors to affect bank's behaviour before it's too late. PCA offers additional safeguards to the banking system. It establishes a set of pre-emptive supervisory actions according to bank's capital. These corrective actions are increasingly strict with banking capital level (see table 1). It limits supervisors' discretion and consequently, allows reducing supervisory forbearance. Indeed, PCA relies on a simple publicly verifiable and hard to manipulate indicator providing early signals of banking risk.

Furthermore, PCA policy has the advantage to be set up despite national divergences in supervisory practices and legislations in Europe.

Table 1: Prompt Corrective Action

Capital Threshold	Total Risk-Based Capital	Tier 1 Risk-Based Ratio	Tier 1 Leverage Ratio
Well capitalized	≥10%	≥6%	≥5%
Adequately capitalized	≥8%	≥4%	≥4%
Undercapitalized	<8%	<4%	<4%
Significantly undercapitalized	<6%	<3%	<3%
Critically undercapitalized	Tangible equity ≤ 2%		

Source : Aggarwal and Jacques (1998)

There is today a consensus on PCA positive impact on banks' capital level and risk taking (Benston and Kaufman, 1997) and, its usefulness has not been invalidated by the crisis. PCA effectiveness depends on the accuracy of its triggers (Nieto and Wall, 2006). The US version of PCA is only based on a set of capital triggers. The quick propagation of the recent crisis suggests that PCA time of reaction should be reduced. It also revealed the need to broaden the category of institutions subject to PCA and, the necessity to improve its triggers. Consequently, the European version of PCA should consider other triggers better fit to banking practices and, would allow supervisors to react earlier. It should be applied to all systemic shadow banks and not only to commercial banks.

3.2. The choice of the triggers.

The main question is about the adequacy of traditional regulatory tool to correctly address concerns arising from these large and structures. Considering the modification of banking activities we have described above, a banking regulation system focusing only on capital adequacy seems to be depleted. Since the 80s, capital requirement has been the cornerstone of banking regulation. The reason for this decision is that capital regulation provides a buffer against insolvency,affects incentives for risk taking and provides a room for an early

intervention by the supervisor (Dewatripont and Tirole, 1993). Unfortunately banks' new practices make capital level increasingly dependant on markets[2]. Experience has demonstrated the potential weakness of a reliability based on capital adequacy ratios to trigger supervisory intervention mainly because they are calculated using balance sheet data. So, they produce backward-looking indicators which are not adequate to anticipate potential changes in banking condition (White, 1997).

A risk-based capital measure isn't efficient as trigger for early corrective intervention because most of the banks which faced difficulties during the crisis were well capitalised according to this criteria. According to the simple leverage ratio[3] used in PCA, most of them would have been considered as risky banks. The leverage ratio is easy to measure, publicly verifiable and hard to manipulate which, limits the potential of underestimation of risk by banks. As its calculation is independent of any complex modelling assumption and calibration procedures, it reduces the risk of regulatory capture. Nevertheless, if a simple leverage ratio is a good trigger for traditional banks with essentially a banking book, it seems to be inefficient for the new banking model we have described. To fill this gap we can imagine a double criterion. A composite measure to classify banks can be useful because it seems impossible to have the true signal of changes in bank risk profile using one independent signal mainly due to the evolution of banks practices. Moreover, it is largely admitted that using multiple indicators allows to better estimate banking organisations risk profile than each taken alone. Even if they are noisy signals, they can provide a more accurate estimate of a banking organisation true condition (Flannery, 2001). The task assigned to this composite measure would only more accurately classify banks as risky or not risky and, prevent to predict bank failures. Making this distinction is essential because the early prediction of bank failures requires a more

[2] See section 2 for an analysis of the interaction between banks' solvency and markets.
[3] In PCA, leverage is interpreted strictly as the ratio of total assets to common equity.

complete analysis of banks'condition considering information about assets quality, management quality, earnings in addition to information about capital adequacy and liquidity risk.

One alternative to relying only on capital adequacy ratios to trigger supervisors' intervention is to complement them by a market-based indicator. There is now a consensus on market data potential interest in the supervision of banking organizations, especially for large and complex financial institutions. Banking market information which is taken from the observation of the securities they issue, can be particularly useful to complement traditional balance sheet data in the assessment of bank fragility. Many papers provide evidence that market indicators are particularly informative for banks in industrialized countries (Flannery, 1998; Gropp and al, 2002). Some papers even suggest that market data may contain information which are not yet included in the confidential information obtained by supervisors. They conclude that supervisory information and market information are complementary (Berger and al, 2000; Evanoff and Wall, 2001). Some other studies have investigate the performance of market indicators at predicting changes in banks risk profile relatively to traditional balance sheet-based indicators ones. Their results show that supervisory assessments are generally less predictive than market indicators (Berger and Al, 2000). Consequently, some of them suggest supervisors should monitor subordinated debt spreads and use them for timing the US PCA (Evanoff and Wall, 2001). Other authors propose to use market information to prompt a more intensive monitoring of an institution (Greenspan, 2001) or to rank banks into different classes of risk in the PCA framework (Calomiris, 1999; Evanoff and Wall, 2003). But obtaining high quality market data in order to get a clear signal for supervisors, can be a hard task. That is why market information should be used really cautiously in the triggering of

supervisory intervention. As we speak, many supervisors remain reluctant to use market information in this way.

In this paper we follow the idea that supervisors should complement capital information with another kind of information to rank banks according to their risk profile in the PCA framework. Gradual capital requirement according to their liquidity risk could be a solution to better capture risky and systemic banks. The transformations in banking practices reinforce links between insolvency and illiquidity. Introducing a liquidity measure as a PCA trigger will take into account the dynamic interaction between market and funding liquidity and also between the liquidity and the solvency of financial institutions. Consequently the idea that the regulation of bank capital and the regulation of liquidity risk must be overlapped together. The new relations between market and banking liquidity justify the introduction of a liquidity ratio in the set of indicators designed by the regulator to implement its new form of PCA. It should discourage these excessive practices and incite banks to modify their funding profiles in reducing liquidity risk through the economic cycle (Aglietta and Scialom, 2009).

So, European PCA trigger should be a composite measure incorporating both capital adequacy ratios and, a liquidity risk measure. This composite indicator should improve the detection of risky banks and consequently allow supervisors to intervene early. This will reduce the resolution costs of the failure of big institutions by reducing the amount of liquidity injections necessary.

Different indicators can be used to evaluate the liquidity of an individual institution. We can for example mention funding diversification, a liquid assets ratio[4] or, limits on maturity mismatches. But, evaluating liquidity risk in practice seemed to be an hard task for many

[4] The liquid assets ratio represents the stock of liquid assets available to the bank at their market value.

reasons. First, defining liquidity can be very difficult because it is a concept depending greatly on the historic, geographic and, economic and financial context. Some assets considered as liquid during a period can suddenly become illiquid in the following period. So, liquidity buffers used by banks to prevent liquidity problems can imperfectly capture the real liquidity risk the bank bears. The book value of the assets can greatly differ from the liquidity they are able to generate so, it may be difficult to know which assets are really liquid.

Second, according to the measure used to assess the evolution of liquidity risk the results may hugely change. The fact that liquidity monitoring practices can differ between institutions represents also a huge barrier for liquidity supervision as comparability is a crucial characteristic. Indeed, supervisory practices concerning the evaluation of liquidity risk amongst European countries may also greatly differ.

In this paper we follow PCA spirit to measure banking liquidity risk. PCA requires triggers easy to measure, publicly verifiable and hard to manipulate so, we will not try to obtain a perfect measure of liquidity risk. We will only try to obtain a simple representative measure of this risk. To define liquidity risk we consider the ratio of liquid assets to total deposits and short term funding. We call this measure Maturity Mismatch Ratio (MMR). This choice is motivated by the fact that the crisis demonstrated that the impact of the liquidity shock on a bank depended on their degree of reliability to wholesale funding. Such wholesale funds are usually raised on a short term basis with instruments such as Fed Funds, repurchase agreements, large denomination certificate of deposit (Jumbo CDS), interbank deposits and, commercial papers.

4. Empirical results

4.1. Data and methodology

To motivate the potential use of a liquidity risk measure to detect high risk banks, we compare the accuracy of capital ratios and liquidity risk indicator to identify severely troubled institutions in a timely manner. To achieve this goal, we begin our empirical analysis by carrying out a purely statistical methodology. We propose first a new classification for PCA leaning on the double criterion capital adequacy and liquidity risk to trigger supervisory intervention and, we compare capital adequacy ratios and MMR for risky banks. The second step consists in performing standard logit regressions to identify the banks that are at risk. This econometrical analysis will allow us to reinforce our results. Lastly, we compare the performance of the two rating systems to identify risky banks.

We use a sample consisting of an unbalanced panel of annual report data from 2000 to 2008 for a set of European commercial and cooperative banks established in 15 European countries: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzer land, and Germany. A majority of banks do not give information on some variables needed by this study (especially tier 1 capital ratio and risk-based capital ratio). Also, we delete banks with more than two years of time series observations missing. The final sample consists of 139 European banks.

The MMR when available are obtained for each of the banks using the following process: we compute the ratio of the liquid assets to total deposits and short term funding. Leverage ratios are considered as the ratio of equity to total assets. As banks' failures are still rare events in Europe, we decide to consider each bank which benefit for a specific state measure as defaulting. These state measures can take the form of guarantee schemes, recapitalization measures, loan to banks, the acquisition of impaired assets and nationalizations. We also use specific terms like closed, recapitalized, suspended or merged as key words in the Bankscope

database (Bongini, Laeven and Majnoni, 2001). All the data are obtained from Bankscope database.

4.2. Statistical analysis

The statistical analysis below focuses on the observation of European commercial and cooperative banks during the 2007 "subprime crisis". The objective of this part of the job is to statistically test if banking supervisors should consider the information about maturity mismatch to complement capital adequacy information to trigger their intervention on a specific bank. To empirically test the ability of the MMR to identify risky banks, we need first to specify the appropriate threshold for defining at-risk banks according to the maturity mismatch criteria. The threshold we used to define risky banks is obtained through a statistical optimization in the sense that it represents the threshold level with the best performance to correctly classify bank default when evaluating the power of the different thresholds. We also take into account the neutrality of the threshold. The idea is to choose the threshold which doesn't excessively consider banks as risky nor excessively misses risky banks. The cost to the decision-maker of taking preventive action relative to the cost of an unanticipated banking crisis is also an important aspect to take into account. The best threshold to identify risky banks is a MMR < 25%.

Then, we analyze the accuracy of failing banks identification according to the maturity mismatch criteria. The higher will the probability of a type I error and the lower will be the probability of a type II error, and vice versa. Table 3 shows type I and type II errors associated to the MMR. It is important to analyze misclassifications because it represents a prerequisite for generating costs and or benefits from initiating PCA with maturity mismatch ratios.

The MMR correctly classifies 21 out of 48 failing banks and 60 out of 91 non failing banks. It fails to correctly classify 26 failing banks out of 48 (type I error) and wrongly classifies 32 healthy banks out of 91 as failing banks (type II error).

Table 3: Type I and Type II Errors

Cutoff point: MMF < 25%		Actual failure		
		Yes	No	Total
Classified failed	Yes	38	107	39.6%
	No	5	13	69.76%
	Total	44.68%	62.5%	

Source: author calculations.

These results suggest that the maturity mismatch criterion tends to excessively classify banks as risky.

To refine our analysis we observe the percentage of failed banks with a risk-based capital ratio < 8%. We repeat the operation considering a leverage ratio < 4% and a maturity mismatch ratio < 50% (see table 4). Of the 48 banks that failed, none had a risk-based capital ratio (RBCR) < 8% and, 50% had a leverage ratio (LR) < 4%. Around 79.1% of them had a MMR < 50%. This suggests that the MMR outperforms RBCR and LR to identify risky banks. However, as expected, the leverage ratio outperforms the RBCR in the identification of risky banks.

Table 4: RBCR, LR and MMR detection performance

Criteria	% of failed banks
RBCR<8%	0
LR<4%	50
MMR<50%	79.1

Source: author calculations.

Table 5 shows the MMR of the banks considered as well capitalized and adequately capitalized according to the risk-based capital ratio criteria.

Of the 48 failed banks , which are considered as well capitalized or “adequately capitalized” by the risk-based capital ratio, 4.1% were considered as risk class 1 by the MMR criteria, 16.6% as risk class 2, 47.9% as risk class 3 and, 31.25% as risk class 4. Almost all the failed

banks are considered as risky according to the MMR (i.e. MMR < 50%) what suggests that if supervisors had taken this criterion into account they should have reacted earlier.

Table 5: MMR of "well capitalized" or "adequately capitalized" banks according to the RBCR criteria

MMR level	% of banks
≥100%	4.1
≥50%	16.6
<50%	47.9
≤25%]	31.25

Source: author calculations.

To resume, we can say that the results of the statistical analysis are consistent with what we were expecting. They suggest that the MMR is a good indicator to detect risky banks. They also confirm that when one considers the MMR, the identification of risky banks is improved comparatively to the cases when one considers capital adequacy ratios.

4.3. Logit estimations

To motivate the potential use of MMR as a PCA trigger, in this section we contrast the relative accuracy of capital ratios and maturity mismatch ratio in predicting bank condition. Our objective here is not to build a comprehensive failure prediction model, but rather to test the performance of MMR relative to the signaling measures that are currently being utilized to initiate supervisory action. Thus, as was done for sub-debt yield spreads (Evanoff and Wall, 2001), our focus is on relatively simple uses of the capital and maturity mismatch ratios to test the univariate power of each indicators to identify problematic banks. To ensure the robustness of our results, we separate the available data set into one "in" and one "out" sample subsets by randomly splitting the data into two sub-samples. The first one contains approximately 70% of all observations. We considered it as a learning dataset and we used it to estimate the model. The second one is considered as a validation dataset and is used for an out sample evaluation. When splitting the data, we ensure that the ratio of problematic and

non-problematic banks was equal in both datasets. We code 1 when the bank is identified as "risky" and 0 otherwise.

We first analyze the extent to which the various risk measures convey different information. So, we begin by performing Spearman rank order and Pearson correlations (see table 6). The Spearman rank order correlations reveal that tier1 risk-based capital ratio (T1R) and risk-based capital ratio are closely linked each other. This result was expected. They are both quite linked to the leverage ratio which can be explained by the fact they all give information about banks capital adequacy extracted from balance sheet data. The maturity mismatch ratio is not closely associated with leverage ratio, tier1 risk-based capital ratio or, with risk-based capital ratio. The Pearson correlations give similar results than the Spearman rank order correlations. They reveal a weak correlation across the different indicators that justifies their joint use in the actual PCA. Consequently, the maturity mismatch ratio and capital adequacy ratios convey different information. This means that they can be used simultaneously.

Table 6: Pearson and Spearman rank correlation* coefficients for RBCR, T1R, LR and MMR

	RBCR	T1R	LR	MMR
RBCR	1	-0.0096 (0.6949)	0.0792 (0.2121)	0.0147 (0.1290)
T1R	-0.0096 (0.6949)	1	-0.0008 (0.3055)	-0.0040 (0.1267)
LR	0.0792 (0.2121)	-0.0008 (0.3055)	1	0.1534 (0.1433)
MMR	0.0147 (0.1290)	-0.0040 (0.1267)	0.0265 (-0.0236)	1

*Spearman rank correlation coefficients are provided in parentheses.
Source: author calculations.

Table 7 reports the results from estimating logit-models with different time leads. All coefficients are different from zero but only RBCR has the expected sign. As expected, the variables which are directly linked to capital adequacy have the greatest informative

importance. Among these variables, the RBCR has by far the most predictive power. This result can be explained by the fact that RBCR represents the most complex and accurate measure of bank capital adequacy.

The MMR is significant at the 1%, 5% and 10% levels for the two years-lead. The coefficient ceases to be significant one year before the event. The % correctly predicted of roughly 95% reveals a high discriminative power of all four models. The results for the MMR strongly support the proposition to take into account liquidity risk information to identify risky banks. This finding is consistent with the statistical analysis results.

As measured by the R2, the logit model with three capital ratios seems to explain the default probability better than the other models. However, the R2 presented in table 3 are quite low, indicating that the model only poorly fits the levels of the default rates.

As a simple robustness check, we estimated the corresponding logit models for the out sample. We found essentially unchanged results for the one-year horizon estimations, in terms of significance. The results are different only for the Leverage Ratio which, becomes significant in the out sample estimations. At the opposite, the results are quite different for the two-year horizon estimations. The Tier1 capital ratio and the Leverage Ratio become significant in the out sample whereas, at the same time, the Maturity Mismatch Ratio become insignificant. However, this last one is not far from remaining significant at the 10% level.

Table 7: Predictive performance of the MMR indicator: logit estimations

One-year prediction

Variable	Coefficient	Standard error	z	P>|z|
Intercept	-3.1816	0.1945	-16.36	0.000
MMR (-1)	0.0011	0.0009	1.22	0.223
% correct (in sample)	95.73		% correct (out sample)	95.48
Pseudo R^2(in sample)	0.0043		Pseudo R^2(out sample)	0.0128

Two-years prediction

Variable	Coefficient	Standard error	z	P>|z|
Intercept	-3.1119	0.1976	-15.75	0.000
MMR (-2)	0 .0021	0.0008	2.59	0.010
% correct	95.24		% correct (out sample)	95.19
Pseudo R^2	0.0213		Pseudo R^2(out sample)	0.0962

In sample results

Variable	Parameter estimate (1)	Parameter estimate (2)
Intercept	-1.8690 (0.031)	-2.0229 (0.026)
leverage ratio	0.0001 (0.923)	-0.0001 (0.935)
risk-based capital ratio	0-.1132 (0.136)	-0.0976 (0.215)
Tier1 capital ratio	0.0002 (0.071)	0.0002 (0.075)
maturity mismatch(-2)		0.0023 (0.006)
% Correct (in sample)	95.82	95.14
Pseudo R2 (in sample)	0.0280	0.0520

Out sample results

Variable	Parameter estimate (1)	Parameter estimate (2)
Intercept	-2.6559 (0.049)	-2.7134 (0.000)
leverage ratio	-0.5051 (0.003)	0.0001 (0.814)
risk-based capital ratio	0.3574 (0.084)	-0.0031 (0.917)
Tier1 capital ratio	-0.2573 (0.189)	-0.0421 (0.513)
maturity mismatch(-2)		0.0023 (0.007)
% Correct (out sample)	96.11	95.33
Pseudo R2 (out sample)	0.1786	0.2451

Authors'calculations

To resume, the logit models results confirms the results previously obtained by the statistical analysis. The two results converge on the superiority of MMR over capital adequacy ratios. This demonstrates that the maturity mismatch ratio, quite correctly reflects bank liquidity risk. Consequently, it can be used as a PCA trigger as simplicity is one of the features required for PCA triggers. These results suggest that the modification of banks' structure which, convey to an increased dependency to market liquidity has to be considered in the new European regulatory framework.

4.4. Comparison of the rating systems

We determine 4 thresholds allowing us to distinguish 5 new risk classes according simultaneously to capital adequacy ratios and to the MMR. The best threshold to identify risky banks is a MMR < 25%[5]. We consider it as the lower limit. To define the upper limit, we follow the idea that a bank is considered as safe when its liquid assets fully cover its short term liabilities that is to say a MMR ≥ 100%. The risk classes obtained are resumed in table 2.

Table 2: The new PCA rating system

Risk categories	Total risk-based capital ratio	Tier 1 risk-based capital ratio	Leverage ratio	MMR
1	≥10%	≥6%	≥5%	≥100%
2	≥8%	≥8%	≥4%	≥50%
3	<8%	<4%	<4%	<50%
4	<6%	<3%	<3%	<25%
5	Tangible equity ≤2%			

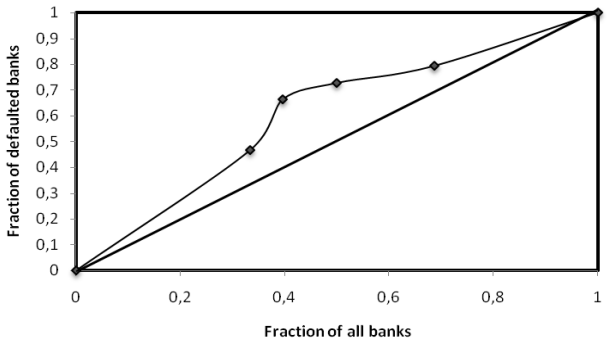
Source: author calculations.

[5] See the statistical analysis page 16.

To compare the accuracy of the two classifications, we relied on the Accuracy Ratio as it is one of the most popular validation technique currently used for estimating the predictive power of rating systems. It measures the power of the evaluated model to correctly classify defaults relative to the power of a hypothetical model that has perfect information on defaults. The quality of a rating system is measured by the Accuracy Ratio. Thus, the rating method is better the closer the Accuracy Ratio is to one (Engelmann, Hayden and Tasche, 2003).

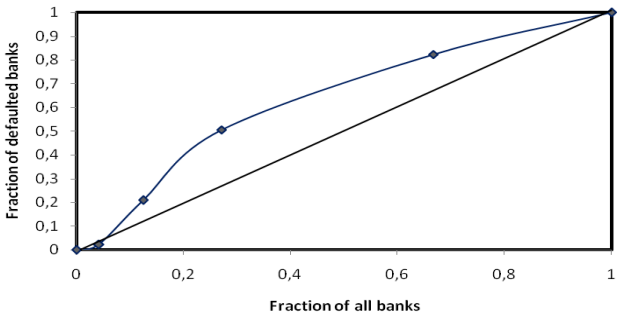
Figure 1: Cumulative Accuracy Profile curves.

PCA current classification



Source: Author calculation

PCA proposed classification



Source: Author calculation

Figures 1 represents the Cumulative Accuracy Profile curves representative of the two classifications. The AR of the actual PCA is around 21.71% and the one of the classification proposed is around 25.86%. We note that these AR are quite low for the two classifications.

The reason can be as mentioned above that capital adequacy information is depleted to reflect the risk a bank represents. Consequently, it is crucial to complement capital ratios information with another source of information. As far as the new classification is concerned, the low AR can result from the fact that maturity mismatch ratios are obtained from bank balance sheet which, provide backward-looking indicators. The estimation of banks' maturity mismatch has to be improved.

Comparing the Accuracy Ratios across the two different model rating systems shows that the classification including a maturity mismatch indicators yields a largest AR than the classification with current PCA triggers. However, the degree of improvement is rather small. Therefore, it can't allow us to conclude with certainty that the classification we propose is better than the existing one.

5. Conclusion

Banking supervisors are now really concerned about bank positions on derivatives and off balance sheet activities because they can require large amounts of liquidity during crisis periods. These new practices in banking activity have created new vulnerabilities. Banking liquidity hardly depends on market anticipations and variations. Due to banking liquidity externalities, market liquidity shocks have now the potential to quickly propagate to money and interbank markets which can severely threaten financial stability. Consequently, it is crucial to monitor liquidity risk associated with these new practices.

The recent financial crisis perfectly illustrated that even well capitalised banks can face severe liquidity problems and everybody is aware of the inadequacy of a banking regulation baesd on the utilisation of capital adequacy ratios. To correctly monitor banks' liquidity risk, it is necessary to take bank liquidity risk into account for the classification of banks.

To motivate the potential use of a maturity mismatch measure as an instrument to detect high risk banks, we compare the accuracy of capital ratios and maturity mismatch indicator to identify severely troubled institutions in a timely manner. We first carry out for a sample of European banks a purely statistical methodology to compare capital adequacy ratio and maturity mismatch ratio accuracy in the identification of risky banks. A second step was to perform logit regressions to reinforce our results. Lastly, we measure the Accuracy Ratios to compare the accuracy of the two classifications.

The statistical results suggest that the maturity mismatch criterion tends to excessively classify banks as risky and that the MMR outperforms RBCR and LR to identify risky banks. Consequently, the statistical results are consistent with what we were expecting.

The logit models results confirms the results previously obtained by the statistical analysis. They reveal as expected that there is a significant relation between bank failure and maturity mismatch. This demonstrates that the MMR correctly reflects banks' liquidity risk. Consequently it can be used as a PCA trigger. These results suggest that the modification of banks' structure, which conveys an increased dependency to market liquidity, has to be considered in the new European regulatory framework.

Thanks to the statistical analysis, we determine 4 thresholds allowing us to distinguish 5 new risk classes regarding simultaneously to capital adequacy ratios and to MMR. We note first that the Accuracy Ratios for the two classifications are quite low. Comparing the Accuracy Ratios across the two different model rating systems shows that the classification including a maturity mismatch indicators yields a larger AR than the classification with current PCA triggers. However, the degree of improvement is rather minimal. Therefore, it cannot allow us to conclude with certainty that the classification we are suggesting is better than the existing one.

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