RESEARCH PAPER

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Table of Contents

Abstract

The main purpose of this paper is to determine the macro-prudential indicators of financial stability that can be used for supervising the banking system in the CEMAC zone. Going by a set of indicators drawn from similar works on macro-prudential supervision, and, more specifically, aggregate microeconomic variables of the banking sector, macroeconomic variables and combinations of the two, we were able to identify those that are relevant in analysing an imminent deterioration of the banking system in the subregion. At the end of this study, it was realised that claims on the private sector, foreign direct investments and the combination of exports and credits to the private sector, increase the risk of degradation of the banking system, while this risk is reduced by an icrease in the exchange rate, increase in the internal resources of the banking system and inflation rate. The regulator should therefore bear this set of indicators in mind in order to facilitate a quick response to offset any potential banking crisis in the CEMAC region.

Keywords: Banking System, Macro-Prudential Indicators, Weakness, Degradation
JEL Classification: C12, C13, G21, G28

Résumé

L'objectif du présent travail est d'identifier des indicateurs macro-prudentiels de stability financière pouvant servir dans le cadre d'une surveillance du système bancaire en zone CEMAC. Partant d'un ensemble d'indicateurs répertoriés dans la littérature sur la surveillance macro-prudentielle, notamment des variables microéconomiques agrégées du secteur bancaire, des variables macroéconomiques et des combinaisons de ces deux ensembles, nous avons déterminé les plus pertinents dans l'annonce d'une dégradation du système bancaire de la sous-région. A l'issue de cette étude, il ressort que, les créances sur le secteur privé, les investissements directs étrangers ainsi que la conjonction des crédits au secteur privé et des exportations, accroissent le risque de dégradation du système bancaire. A contrario, ce risque est réduit par l'appréciation du taux de change, l'augmentation des fonds propres du système bancaire et du taux d'inflation. Cet ensemble d'indicateurs devrait donc retenir l'attention du régulateur afin de permettre une intervention rapide qui résorberait toute crise bancaire potentielle en zone CEMAC.

Mots clés: Système Bancaire, Indicateurs Macro-Prudentiels, Fragilité, Dégradation.
JEL Classification: C12, C13, G21, G28

Introduction

Analysing the stability of a financial system is of prime importance, given the likely adverse effects[4] that a financial crisis could have, not only at the level of economic activity but also at the social level. For some years now, we have been witnessing the development of a new analytical approach, referred to as the macro-prudential approach, for preventing crises in the banking system. Actually, the micro-prudential approach, which for long was the only method used as a crisis warning system, has today shown its limits[5], as it emerges from recent financial crises that it is not enough to monitor banking indicators to be able to make dependable forecasts on a failure of the system. Moreover, excessive recourse to micro-prudential rules can even compound the aversion of banks for risk-taking and lead to the bankruptcy of some institutions (Borio [4], 2003).

The macro-prudential approach appears today to be an improvement in microprudential monitoring that helps to assess the global exposure of the banking system to a financial crisis. According to Sundararajan et al. (2002)[6], "macro-prudential analysis refers to the assessment and control of the strengths and weaknesses of a financial system in terms of macroprudential indicators made up of indicators of financial soundness and other macroeconomic indicators, such as the GDP growth rate and inflation rate, with information on the structure of the financial system, qualitative information on the institutional and regulatory framework, in particular, by assessing consistence with international standards and codes, and the results of tension tests." Therefore, macro-prudential analysis helps the regulator to have a holistic view of the banking system. Evans [13] (2000), in a comprehensive study, identified a set of macroprudential indicators which he divided into two categories: aggregate microprudential indicators and macroeconomic indicators. However, the diversity of financial systems and the multiplicity of indicators identified require the local regulator to assess which indicators are relevant for a particular financial system.

In the late 1980s, the banking system of the CEMAC zone, under the supervision of BEAC, witnessed some shortcomings (individual bankruptcy, illiquidity situation, etc.) with negative consequences on economic activity in the sub-region (Djine and Tamba [23], 1995). This crisis was the result of the poor management of these financial institutions and the deteriorating terms of trade during those years. Today, globalisation and interconnexion of financial markets increase the probability of spillover effects that can lead to the "importation" of a banking crisis. Consequently, it is today necessary to strengthen the supervision mechanism in order to take into account both the individual situations of banks and the overall resilience of the banking system, with a view to reducing the risk of banking crisis monitoring. A lot of efforts have been made to this end since the mid 1990s. Today, the authority in charge of ensuring financial stability works with a set of macroeconomic variables. However, it would be interesting for it to know precisely

[4] The weaknesses of a banking system, be it in a developing country of in a developped country, can be a threat to financial stability both within the country and at the international level (Bále [8], 1997). Also see Borio [4] (2003), Plihon et al. [19] (2004), for a better understanding of the consequences of the instability of a financial system.
[5] Goodhart [25] (2004) cites the case of Japan in 1998, where banks taken individually were financially strong, but all vulnerable to the crisis of the housing sector.
[6] Quoted by Yung Chul [25].

which variables are the most relevant for assessing the financial system. In other words, what will be the convincing power of each variable to forecast a degradation of the banking system? This approach, which seeks to significantly reduce the number of variables that could be used to predict a banking crisis and assess the predictive power of each of them, has a two-pronged advantage in terms of efficiency and cost. The regulator can easily read into the situation of a banking system, as it will no longer be necessary to attach the same importance to all the several indicators, but to concentrate on those which, if adjusted, can lead to an increase in the probability of predicting a failure in the system.

The purpose of this research paper is to determine the indicators of financial stability that could be used in monitoring the banking system in the CEMAC zone. Specifically, going by a set of indicators drawn from similar works on macro-prudential supervision, we intend to identify those that are relevant in analysing an imminent deterioration of the banking system in the sub-region.

This paper is divided into two parts. Part I examines banking system supervision by dealing with the microprudential approach in section (1) and the macroprudential approach in section (2). Part II is a presentation of the methodology used and the results obtained, first by indiacting the theoretical analytical framework in section (3), and then by putting the theoretical framework into practical use and looking at the econometric model in section (4). In section (5) we attempt to propound the parameters of the model and analyze the results obtained.

I. Monitoring the banking system

According to the European Central Bank, financial stability refers to a situation in which the financial system is capable of resisting shocks without triggering adverse knock-on effects on the use of savings, investment and payments processing in the economy (Tordjman [24], 2007). The monetary authority has more reasons than one to be concerned with the stability of the banking system. Firstly, such stability can be considered a public good, meaning a good characterized by non-rivalry and non-exclusion. This is where the supervisory authority comes in to make it freely available to users (banks, households, etc.) and ensure its preservation. Secondly, banks are considered key players in the popularization of the monetary policy of the Central Bank (Landau [18], 2009). In case of a weakness in the banking system, it may be more costly for the Central Bank to tighten its monetary policy (IMF [14], 2006)[7]. Finally, commercial banks represent a big share of the clientele of the Central Bank which must thus constantly seek to monitor their situation and solvency (op. cit [14]).

The banking system is generally exposed to two types of risk that could lead to a crisis situation. Firstly, internal or endogenous risk that comes from within each bank that makes up the system and which is seen in its income statement. This type of risk is examined mainly through the microprudential approach which assesses the weakness of banks, with such weakness being deduced from the bill of health of all the banks[8]. Secondly, external or exogenous risk of the bank which comes from two main sources: the contagion effect and the macroeconomic environment in which the bank operates. The macroprudential approach, with ultimate goal to assess the risk of generalized weakness of the financial system and not only individual institutions will be used to factor in this type of risk (De Bandt and Oung [11], 2004).

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1 The microprudential approach

1.1 Definition and objective

This approach, which entails the individual assessment (internal control) of each financial establishment, is in line with the recommendations of the Basel Committee on Banking Supervision. Here, the supervisory authority has to ensure that banks comply with the regulations relating to the management, caution and dissemination of information, in order to protect depositors and guarantee confidence in the banking system.

1.2 The tools used

Several authors (Shen and Hsieh [21], 2004; Cole and Gunther [7], 1998) analyse two micro-prudential monitoring variants. The first one is based on a periodic audit of banks and the second

[7] Actually, the frailty of the banking system generally leads to panic among depositors who usually react by withdrawing their savings from banks. This could create the phenomenon of "bank runs" which devolves on the Central Bank which will then act as a last resort lender. This situation then increases the amount of liquidity circulating in the economy and could lead to inflation

[8] This approach is known as as the Bottom-Top Approach.

on observing a set of financial stability indicators (FSIs) calculated using the data transmitted by banks.

Auditing a bank helps to control its financial situation in keeping with applicable regulations and ascertain the accuracy of the information it transmits to the supervisory authority. It thus helps the supervisory authority to have reliable information on each bank. However, this approach is quite costly both for the supervisory authority and for the bank. The number of audits should thus be few and far between, sometimes once a year. To ensure some level of continuity in control, the audit should be conducted using the data transmitted more regularly by banks, meaning that micro-prudential financial stability indicators[9] (FSIs) will be used.

FSIs are indicators which give information on the situation and stability of the financial institutions in a country, and on those of companies and households with which they interact (IMF [14], 2006). Determining the "FSIs" is of prime importance in ensuring efficient supervision of banks. Actually, FSIs can act as filters which retain only a few banks for indepth assessement. These FSIs from the accounting situation of the bank can be transmitted to the supervisory authority on a regular basis. It can then use the information so received to determine the situation of the bank. FSIs can also be grouped into sectoral data, thereby facilitating a shift from the micro-prudential approach to sectoral monitoring.

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For an institution, FSIs are generally got using the ratio of variables relating to its liabilities and assets, which give an idea of its solvency. In banking, these indicators are divided into two sub-groups (op. cit [14]): central indicators which every banking system is required to produce, and complementary indicators which banking systems are encouraged to produce. Central indicators cover risks related to the adequacy of owners' equity, the quality of assets, profitability, liquidity and exchange rate. The supervisory authority summarizes the information provided by FSIs through a bank rating system that helps to classify banks. This ranking can be done using a discriminating analysis or a logit-probit model; meaning that the scores can be calculated and classification done automatically as soon as FSIs are received from banks[10].

1.3 Limits of the approach

In addition to the structural disadvantage of not considering the macroeconomic environment and the difficulty of aggregating the results obtained for each bank into the system, the micro-prudential approach has two other equally important shortcomings: firstly slowness in predicting banking system weakness and secondly difficulty in identifying threats to the system.

In deed, even if we suppose that the problem of aggregation is solved, microprudential indicators reflect the situation of a bank at a given time. Considering fluctuations in economic activity, these indicators could be used to make forecasts of imminent crises (if we adopt a pessimistic attitude)

[9] The term micro is used as against the term macro which refers to the aggregation of these indicators to assess the stability of any banking system.

[10] In the early 1970s, the United States Federal Reserve developed a rating system that helped to determine the frailty of a bank. This system referred to as CAMEL is based on five criteria: capital adequacy, quality of assets, quality of management, profit level, and liquidity level. In this rating system marks ranging from 1 to 5 are awarded to each mark, in increasing order of frailty.

which never occur; or, if we adopt a cautious attitude, make very belated forecasts of crises which actually occur, for corrective measures to be taken.

Moreover, once banks are classified as weak or not, if the aggregation of this ranking betrays some frailty of the banking system, it will then become difficult for the supervisory authority to identify the sources of this systemic frailty such that the necessary macroeconomic measures can be taken[11].

Redressing the system could thus be done case by case. This has the disadvantage of being very costly for the regulator, encouraging moral vulnerability[12] and providing only tentative solutions.

2. The Macro-prudential approach

The need to be able to predict periods of instabilty in the banking system became crucial at the end of the period of the global crisis of the 1990s[13]. In the face of numerous economic and social hardships caused by these different crises, the international community (policy makers, researchers, etc.) began to consider in what way it could be possible to improve the mechanism used at the time to monitor the financial sector. One of the responses to this question happened to be what is today called "macro-prudential analysis of the stability of the financial sector". This section is entirely devoted to presenting this analytical approach. After defining the concept and outlining the composition of the macroprudential indicators, we will then examine the application of this approach.

2.1 Definition

According to Borio [5] (2008), it is not easy to find a universally accepted definition for the term "macro-prudential" because, even if the connotation to which it refers is directly recognizable, its meaning remains largely ambiguous. In our literature review therefore, we identified some approaches on how to define the concept. The approach adopted at the BIS[14] entails defining the term "macro-prudential" using its opposite, the term microprudential. According to this conception, the macro-prudential approach is a (good) complement of the microprudential approach which helps (by taking into account macroeconomic factors) to perfect the banking system monitoring mechanism by taking into account not only the individual exposure of banking institutions but also that of the system as a whole.

Similarly, in their attempt to define macro-prudential indicators, Evans [13] (2000), Hilbers et al [16] (2000) state that these are pointers to the health and stability of the financial system which can be used to assess its vulnerability to shocks.

[11] Individual bank frailty indicators can differ under the action of one and the same macroeconomic indicator which then constitutes the cause which must be tackled (Bernanke [2], 2008).
[12] This means that a bank will take risks while counting on the regulator to take action in case of problems.
[13] Many regions of the world were affected, some of the most recurrently crises cited are the contagion effect in Latin America (1994) and Asia (1997).
[14] Bank of International Settlements (BIS).

The macro-prudential approach brings together a series of methods that can be used to assess the impact of a macroeconomic shock on the stability of the system by dint of the aforementioned indicators of weakness in the banking system. Unlike the microprudential approach, this approach attempts to assess the overall vulnerability of the system. The objective is, not to protect the deposits of bank customers, but rather to prevent a systemic crisis that can lead to high costs due to a drop in economic activity or the recapitalization of the banking system. Instead of attaching a lot of importance to each bank as an independent financial institution, the macroprudential approach rather considers the contribution of the bank in terms of risk induced on the system (Crockett [10], 2000).

Comparing Macro and microprudential approaches		
	Macroprudential approach	**Microprudential approach**
Operational objective	Reduce the risk of weakness of the entire system	Reduce the risk of bankruptcy
Ultimate objective	Avoid losses (in GDP points) due to a financial crisis	Ensure the protection of investors and creditors
Types of risk	(Partly) Endogenous	Exogenous
Correlation and contagion effects between institutions	Important	Not pertinent
Monitoring method	In terms of overall weakness of the system (top-bottom)	In terms of individual weakness (bottom-top)

Source: Borio [4] (2003)

Thus the take home message here is that the main aim of the macroprudential approach of monitoring the financial system is to protect the entire system. It does this by putting in place an early warning system on the periods of weakness of the said system. The said warning system should be based on information concerning the structure of the system, the observation of aggregate macroeconomic and microeconomic financial stability indicators (FSIs) (Cih´ak [6], 2005); with their evolution having been earlier compared to that of the system's vulnerabilty.

2.2 Composition of Macro-Prudential Indicators (MPI)

Macroprudential indicators are generally made up of two main groups of variables: aggregate microprudential variables obtained by collating information on the individual viability of financial institutions, and macroeconomic variables which have a potential influence on the financial system. It would however be presumptuous to think that, on their own, the above-mentioned variables are enough to help make dependable forecasts on the bill of health of the financial system. In this connection, Evans [13] (2000) notes that, in making an overall appraisal of the financial system, it would be advisable to consider the qualitative characteristics of the system[15].

[15] He makes mention among other things of "the structure of the financial system and markets; the regulation to lay down accounting standards and others as well as obligations to divulge information; rules governing the classification of loans, provisioning and income recognition and other prudential rules; the quality of monitoring exercised on financial establishments; the legal framework (especially with regard to bankruptcy and foreclosure); incentives, and safety nets as well as liberalization and deregulation movements "

2.3 Application of the macroprudential analysis

According to the *Guide for establishing FSIs* prepared by the IMF [14] (2006), the macroprudential analysis is done by defining a reference framework including four elements:

- Assessing the risk of shocks on the financial system;
- Recourse to Financial Stability Indicators;
- Analysing microfinancial interactions;
- Monitoring the macroeconomic situation.

The macroprudential approach therefore focuses on the factors of vulnerability of the financial system and the interaction between macroeconomic trends and financial stability. For example, this entails being able to detect the vulnerability factors of non-financial institutions in order to reduce credit risk which, if allowed to rise, could lead to an increase in the number of non-performing loans and negatively affect the capacity of the banking system to honour its commitments.

II. Methodological Approach

3. Theoretical framework for analysing the banking sytstem

3.1. Definition of concepts

Before analysing how weak a banking system is, we need to start by defining the various underlying concepts of the theoretical analysis. The outbreak of a banking crisis goes along some stages from the weakness of basic units, banks, to the frailty of the entire banking system coupled with successive periods of deterioration[16]. There is no consensus on the definition of the above-mentioned concepts among the different authors who have written on banking supervision. The various definitions are informed on earlier works (Hermosillo [15], 1999; Bhattacharyay [3], 2003; Shen and Hsieh [21], 2004).

- ✓ **Weakness of a bank.**

A bank is said to be weak when it presents the risk of requiring external intervention to ensure its survival. Thus, the weakness of a bank refers to the risk for the bank to no longer be able to honour its short-term commitments (clients' deposits, loans from other institutions, etc.). Such failure of payment could then be passed on to other economic agents and upset the economic and social environment.

Shen and Hsieh [21] (2004) identify three approaches used in defining bank failure. The first is to consider the periodic adjudications of bankruptcy by the supervisory authority. The second approach is that which better suits the definition of bank weakness. Here, the situation of bankruptcy is considered as "quasi-bankruptcy" and supposes the intervention of the supervisory authority in order to avoid the total closure of the bank which could be a bad sign for the market. The third approach used by Hermosillo [15] (1999) entails comparing the ratio of bank commitments coverage in relation to a given theshold.

As indicated above, the weakness of a bank can also be analyzed using the CAMEL rating.

- ✓ **Weakness of a banking system**

The weakness of the banking system can be seen as an aggregation of weaknesses of individual banks coupled with the resulting negative externalities. As of today, there is no universally accepted definition for the weakness of a financial system or even a banking system. However, there are generally three characteristics of the notion of financial vulnerability (Bhattacharyay [3], 2003):
– significant loss of confidence of economic agents in the financial system (financial institutions and financial markets);
– inability of financial institutions to efficiently play the role of intermediation;

[16] The use of the terms frailty and deterioration, even though in a pejorative sense, is in line with the preoccupation of the regulator who attaches more importance to the risk of seeing the system collapse, considering the negative consequences of such an eventuality on the economy.

– spreading of financial vulnerability to the entire economy.

As far is the regulator is concerned, this weakness can be seen as a risk for it to have to intervene in order to rescue a banking system. In this case, the degree of weakness is established using the cost of such an intervention. The advantages of this definition are: it is objective, based on individual quantifiable indicators and can be assessed. However, the difficulty with such an approach is how to aggregate the weaknesses obtained for each bank. Two approaches can thus be considered: approach by numbers and approach by costs of interventions.

- ✓ **Deterioration of the banking system**

The deterioration of the banking system is part of the dynamics of weakness. A banking system can thus be said to have deteriorated when it is more fragile at a particular period than at a previous one.

- ✓ **The crisis of the banking system**

This marks the outcome of the banking system deterioration process. It therefore becomes necessary for the regulator to intervene in order to reduce the magnitude of the damage caused by the crisis and boost banking activities.

3.2 Formalizing the notion of banking system weakness

To define the weakness of the banking system, we go by the hypothesis that the situation of a banking system depends only on the situation of all the banks. With this, we can then define the weakness of a banking system using all the banks. The macroprudential approach is therefore aimed at assessing the impact of macroeconomic variables on this weakness.

In this sub-section, we present two methods for aggregating the individual weaknesses of banks into a systemic weakness. To this end, the following variables will be used:

n_{1t}: number of banks ranked as weak under the rating system as of the date t
n_{2t}: number of banks classified as not weak under the rating system as of the date t
E_{1t}: sum of the net commitments of n_{1t} banks classified as weak as of the date t
F_t: intervention funds available in the coffers of the regulator
α_t: level of weaknesses ranging from 0 to 1 as of the date t.

3.2.1 Approach by numbers

This is a direct approach which entails comparing the number of banks deemed weak by the rating system to the number of banks considered to be financially viable. Thus, by adopting the values above,

The banking system will be said to be weak if $n_{1t} > n_{2t}$

From this definition, the higher the number of weak banks in a banking system the weaker it is itself. But such a generalization of the concept of weakness has the disadvantage that it does not take into account the weight of individual banks[17].

3.2.2 Approach by cost of the regulator's intervention

For the regulator, in order to take on board the weight of banks in the weakness of the banking system, it would be advisable to consider the amount of injections necessary to revive it should its weakness lead to a banking crisis. But, in the event of a crisis, the banks the regulator already considers to be weak will not be able to refund their debts, meaning that such debts will have to be covered by the monetary authority in order to avoid the total collapse of the banking system. Therefore, the weakness of the system could then be assessed by comparing the cost of a rescue operation of the system in the event of a crisis with the funds available for such an operation. The cost of a rescue operation refers to the sum of net commitments (clients' deposits and debts of the bank minus owners' equity and reserves in the Central Bank[18]) of banks considered to be weak. The degree of systemic weakness will then be defined as the relationship between these commitments and the funds available to the regulator. Let η_t be the degree of weakness of the banking system as of the date *t*.

Therefore:

$$\eta_t = \frac{E_{1t}}{F_t} \tag{1}$$

and

The banking system is said to be weak if $\eta_t > \alpha_t$.

3.3 Formalizing the notion of banking system deterioration

The deterioration of the banking system represents the evolution of its weakness and is thus part of a dynamic process. Therefore, the deterioration of a banking system at a given date is the growth rate of its weakness as of that date.

By considering the approach by numbers, a system can be said to have deteriorated if $n_{1t} < n_{1t+1}$
With the approach by costs, if we let β_t be the deterioration of the banking system as of the date *t*, using the values above, we have:

$$\beta_t = \frac{\eta_{t+1} - \eta_t}{\eta_t} = \frac{\Delta\eta_t}{\eta_t} \tag{2}$$

[17] For example, can it be said that a system with 10 % of weak banks representing 50 % in terms of market share, presents the same weakness as a system with 10 % of weak banks representing a 10 % market share? Thus, when assessing the weakness of a banking system, it would be advisable to take into account the weight of banks.
[18] We can also add the financial claims of the bank less its doubtful claims.

The financial system will be said to have deteriorated or not depending on whether β_t is positive or negative. The rate of deterioration will be found using the absolute value of β_t.

Let d_t be the binary variable of deteroration defined by:

$$d_t = \begin{cases} 0 \text{ if } \beta_t \leq 0 \\ 1 \text{ if } \beta_t > 0 \end{cases}$$

3.4 Another formula (considering all the banks)

Even though the formulae presented above all use the secondary information on the weight of weak banks, they have the disadvantage that they consider only such banks in determining the weakness coefficient. This other approach is based on two hypotheses:
– All the banks are presumed to be weak;
– The contribution (weighting) of each bank to the weakness of the system increases with the risk they represent.

These two assumptions help in finding the coefficient of weakness directly by using the score obtained during the rating. This has the advantage of eliminating the "differentiation" effect[19] which can be noticed by using classes of scores rather than the score itself.

Therefore, we are supposing that the score function is normalized and that it increases with the risk of weakness.

Note that:

s_{it} score obtained by bank i ($i = 1...p$) on date t;
E_{it} amount of commitments of bank i on date t;
F_t amount of funds the regulator has on date t to assist the system.

Then,

$$\eta_t = \frac{\sum_{i=1}^{p} s_{it} E_{it}}{F_t} \qquad (3)$$

In defining the weakness of a banking system, the regulator can decide to attach more importance to the weakest banks, by giving more weight to their commitments in the formula to find the degree of weakness. To this end, we can consider a transformation (f function) which increases the score value of the weakest banks and reduces that of the less weak. With this, we can rewrite the formula above as follows:

[19] If, for instance, we let the score used in defining class 1 to be between 0 and 10, and that used to define class 2 between 10 and 20, then two individuals having obtained 9.8 and 10.1 will fall under two different classes without however being essentially different.

$$\eta_t = \frac{\sum_{i=1}^{p} f(s_{it}) E_{it}}{F_t} \qquad (4)$$

4 Application of the theoretical approach

The definitions and concepts presented above can be seen differently depending on the context of monitoring and the tools of the supervisory authority. In fact, following the characteristics of the banking system, the supervisory authority generally gathers a lot of information from banking institutions. It then uses such information to determine the indicators which will be used to monitor the stability of the system. For reasons of clarity, it is therefore important to establish metadata which help to give a good understanding of the indicators used. In this section, we identify the proxy variables that facilitate the application of the theoretical framework developed above to the case of CEMAC.

The database we have on the all the banks in CEMAC is from SYSCO[20] and includes some twenty variables and concerns all the commercial banks of the sub-region. One of the variables is qualitative and shows a classification of banks into 7 groups[21], while the other variables (quantitative) are microprudential variables recorded on a monthly basis. The database covers the period running from 31/01/2001 to 31/12/2005. Data is not available for some banks which either entered our sample after the starting date or for some other reasons.

According to the SYSCO rating, 67 % of the banks surveyed fall under classes 1 and 2. In order to ensure some fluctuation in the weakness variable, we will consider that groups 1 and 2 represent viable banks while the other groups are made up of banks considered to be weak.

4.1 Construction of a banking system weakness variable

For the construction of this variable, we need to know three elements: the banks considered to be weak during the period under review; the amount of commitments of these banks for each period and the amount of funds the regulator would be ready to inject in order to prevent the system from going bankrupt. Bearing in mind the weakness threshold allowed by the regulator for each period, we can define the binary variable of failure of a banking system.

The banks we have chosen to consider weak, following the SYSCO class distribution, are those of classes 3A and 4B. For each bank, commitments are defined by deposits which include public deposits and private deposits. Since we do not have the variable of the amount the regulator has, to rescue the system, we used the Demirgüç-Kunt and Detragiache crisis determinant [12] (1997). In fact, these authors define a crisis period as a period when the ratio of the cost of rescuing the banking system to GDP is higher than 2%. We suppose that the amount of funds the regulator has

[20] CEMAC bank rating system
[21] The classes are 1, 2, 3A, 3B, 3C, 4A, 4B

as of the date *t*, to rescue the system in the event of a crisis, is a fraction λ of the GDP which we put at 1%.

Thus, for each banking system, the variable "degree of weakness", was got by establishing a relationship between the monthly commitments of the banks of the system which are considered to be weak and 1% GDP of the corresponding quarter.

4.2 Construction of the banking system deterioration variable

Having an idea of the degree of weakness of a banking system is a key input used by the regulator to make decisions. However, it would be advisable for the regulator to buttress his choices with forecasts, on the strength of a limited number of indicators, on the probability of deterioration of the situation of the system. To develop such a forecasting mechanism, we had to assess the system dynamics by comparing successive situations. To this end, we used the weakness variable to build a new quarterly variable that reflects the deterioration of the system, also on a quarterly basis. Monitoring a banking system should be a permanent acitivity. With this, one of the qualities required of a good indicator is that it should be available within a relatively short period of time (at most quarterly). This variable will be used in the regression model which will be developed later. To uniformize the frequency of variables used in the study, some macroeconomic variables presented in this paper were converted to their quarterly values when they were not available following the quaterly frequency. The method to get quarterly values as used here follows the Goldstein and Khan interpolation formula (1976)[22].

Since the objective of this stsudy is to clearly identify the variables which can be used as advanced indicators of the deterioration of the CEMAC banking system, we thought it necessary, after defining the notion of deterioration, to indicate how in real economics we can examine each of its constituent elements. However, in order to ensure proper variability of the deterioration and consisdering the data at our disposal, we had to impose another small condition.

Therefore, the CEMAC banking system will be said to be deteriorating at the date *t* if the rate of variation of the degree of weakness between *t* and *t + 1* is higher than 25%;

This means that if: $$\beta_t = \frac{\Delta \eta_t}{\eta_t} > 25\% \qquad (5)$$

Therefore, we have $$d_t = \begin{cases} 1 \text{ if } \beta_t > 25\% \\ 0 \text{ if not} \end{cases}$$

4.3 Presentation of other variables and data used

In this section we present all the explanatory variables of the model as well as the sources of the data we used to determine the coefficients of the model.

[22] Quoted by SIRI [22] (2007).

The approach adopted in the choice of indicators is that used by Shen and Hsieh [21] (2004), which entails looking for the explanatory variables of the failings in the banking system among the aggregate microprudential variables, the macro-prudential variables and variables derived from micro-macro crossing.

Below are the variables most used and which we had at our disposal in this study. The explanatory variables of the final model will be chosen from among this set of variables. Since the variable of interest here is binary, we will use the ecnometry of qualitative variables.

4.3.1 Aggregate micro-prudential variables

Apart from the SYSCO rating variable and the owners' equity variable, indicated above, we got all the micro-prudential variables for each bank from BEAC. These variables were used to determine which variables will be used as aggregate micro-prudential indicators[23]. The aggregate micro-prudential variables retained are:

- Ratio of owners' equity on total assets (*fp- ta*)

A high value of this ratio for each bank helps to increase resilence and thus reduces the weakness of the system. Setting the adequate level of owners' equity for banks should take into account the overall risk (credit risk and market risk) to which they are exposed as well as their general strategy (BIS [1],2000). The expected sign of the coefficiemt of this variable is thus negative, as it is supposed to slow down the deterioration of the banking system.

- Ratio of bad debts on owners' equity (*credou-fp*)

With this ratio we can assess the quality of the banks' assets. Thus, a high value of this ratio means that the banking system is exposed to an illiquidity risk and increases its weakness.

- Other micro variables tested

We used other micro-prudential variables in order to adopt the suitable model. They are: the ratio of bad debt over total debts, the ratio of loans over deposits, ratio of public receivables over total receivables, ratio of cash surpluses/deficits over owners' equity.

4.3.2 Macro-prudential variables

The macroeconomic data used is drawn from two sources: the World Development Indicator (WDI-2007) of the World Bank for GDP variables and foreign debt, on the one hand, and from the International Financial Statistics (IFS) database of the IMF for the other variables. The variables from WDI are annual and had to be converted into their quarterly values. Some variables got from the IFS are quarterly variables while others are annual.

[23] This calculation was done by finding the sum, firstly for a given month, of all the values observed for all the banks, and the interest variable. Then, the aggregate and quarterly micro-prudential variable was calculated using the quarterly average of previously obtained values.

- GDP growth rate (*tcpib*)

An increase in production leads to an increase in incomes and thus enhances the ability for economic agents to meet their commitments. Thus, an upward movement in GDP is supposed to contribute to an improvement of the situation of the banking system. The expected sign for this variable is thus negative.

- Rate of increase of the Dollar-CFA exchange rate (*tctc*)

Since the countries of the CEMAC sub-region are price-takers, an increase in the exchange rate, all others things remaining equal, leads to an increase in export earnings expressed in the local currency. Since most of the goods imported into the CEMAC region come from Europe, they are not really affected by this increase in the exchange rate. The impact on the banking system should therefore be positive. Consequently, the expected sign for this variable is negative.

- Foreign Direct Investment-GDP Ratio (*fdi-pib*)

With the 1997 Asian crisis, it was realised that foreign capital, which was considered to be a strong contributor to economic growth, could actually lead to a systemic financial crisis. However, there is no doubt that an increase in FDIs has a positive impact on the stability of the financial system. Therefore the sign expected for this variable is negative.

- Inflation (*inflation*)

Generally, one of the objectives of the Central Bank is to ensure price stability. Even though the CEMAC region is witnessing the adverse effects of a high level of inflation, the effects of a moderate level of inflation are rather mixed (Cordeiro [9], 2002). Thus, the impact of the inflation rate on the risk of deterioration of the banking system will depend on the average inflation level. Therefore we cannot express any opinion on the expected sign for this variable.

- Other macro variables tested

Many other macroeconomic variables were tested for the development of the final model. We have such macroeconomic variables as the export/GDP ratio, the foreign debt/foreign exchange reserves ratio, spread (difference between the lending rate and the borrowing rate), money supply/foreign reserves ratio.

4.3.3 Variables obtained from the micro-macro combination

- Ratio of credit to the private sector/GDP of the previous period (*creasp-pib*)

To get this ratio, we divided the claims of the banking system over the private sector for the preceding period by the GDP of that period. This ratio shows the risk taken by the banking sector in intermediation activities. Some works published by the Bank of International Settlements have shown that the ratio of credit to the private sector over GDP is a good indicator of financial

instability (Pollin [20], 2001). The expected sign is positive. Actually, an increase in this ratio reflects an increase in risk taking by banks and worsens the deterioration of the system.

- The Credit-Export Product (*cre-export*)

To find this variable, we multiplied the export/GDP ratio by the ratio of credit to the private sector over total credits to the economy. Considered individually, these two variables are supposed to have contrasting effects on the deterioration of the banking system. In fact, an increase in credit leads to the taking of further risk and thus compounds the weakness of the system, while an increase in exports enhances the capacity of some beneficiaries of bank loans to meet their commitments and thus reduces the deterioration of the banking system.

- Other micro-macro variables tested

We also tested other combinations of micro and macro-prudential variables, notably: the product of the owners' equity variable and the inflation rate variable, the product of the bad debts variable and the GDP growth rate variable.

4.3.4 Choice of the final model

To adopt a final model, we sought to have the most suitable model that can be adapted to our data (without considering groupings by countries) in the light of AIC and BIC information criteria. The procedure we used is the "Backwise" procedure which entails using a logit model containing all the potential explanatory variables, and then successively eliminating those that are less important. Since we had a model with a range of significant variables to a certain level (10%), the choice of the final model was made by comparing the information criteria of the various models. The model we adopted is as follows:

$$fs = g(f\text{-}ta, tctc, fdi\text{-}pib, inf\,lation, creasp\text{-}pib, cre\text{-}export) \quad (6)$$

5 The Econometric Analysis

5.1 The approach adopted

Most studies carried out on this topic end up by making estimates of the data panel; with the panel being made up of either banks or countries (banking sub-system). Given that our study had to cover a set of 6 (six) banking sub-systems, we therefore had to adopt an approach whose outcome could be an estimate of the data panel. However, to do this (make estimates on the data panel), we needed to clearly specify the model, particularly with regard to uniformity between countries.

"From the econometric point of view, this means testing the equality of the individual coefficients of the model under study. At the economic level, specification tests entail determining if it is right to suppose that the theoretical model under study is perfectly similar for all the countries, or if on the contrary there are peculiarities that are unique to each country." (Hurlin [17], 2003).

The initial model we had in mind can be summarized in the following formula[24]:

$$y_{it} = g\left(x_{it}\beta_i + c_i\right) + E_{it} \qquad (7)$$

where $i = 1..N$ (country index), and $t = 1..T$ (time index), E_{it} follows a logistic law.

At the end of the test procedure, there are three possible scenarios:

- **Estimating individual models for each country.**

This case arises where the procedure being used rejects the hypothesis that the coefficients of the explanatory variables for all the countries are equal. Therefore the data production process is not identical for all the countries. With this, we had to estimate the coefficients of the explanatory variables for each country taken individually.

- **Estimating a common model for all the countries.**

This case arises where it is accepted that the coefficients of explanatory variables and those of constants for each country are equal. The data is got from the same generating process and can thus be brought together for estimation purposes. In this case, we use the ordinary assessment parameters for an equation.

- **Estimating a model on panel data.**

This is some sort of an intermediate situation between the two other scenarios presented above. Here, the testing procedure admits the equality of explanatory variables coefficients between

[24] This is certianly a "strong" hypothesis we are making here, but it is generally admitted in the study of temporal series, whereby the coefficients obtained remain stable over time.

countries, but rejects the equality of constants for the countries. This situation denotes the presence of inobservable individual effects for countries, notwithstanding an indentical response in terms of the explanatory variables being considered. The parameters are then assessed using panel techniques with the first stage being to determine whether the inobservable individual effect is a random or fixed value.

Therefore, the next stage of the approach strongly depends on the outcome of the testing procedure presented above. That is why we will start by carrying out this testing procedure in order to determine the assessment technique which will later be used.

We have now come to the extreme case which demands that there should be perfect uniformity between CEMAC countries in view of the variables under consideration. With this, we have to assess the coefficients of each country taken individually.

At the end of this series of assessments of individual equations, we keep in mind that, on the whole, the model adopted turned to be significant at 5% for three countries (Cameroon, Equatorial Guinea, Central African Republic). In these three countries, the effect of the variables considered in the model seems to be virtually the same. The deterioration of the banking system will be reduced with an increase in the resources generated by the system itself, increase in the exchange rate and, paradoxically[25], an increase in inflation. The factors that cause the deterioration of the banking system are: claims over the private sector and foreign direct investments. However, almost all the coefficients obtained are non significant at 5%. This would probably be due to limited number of observations available for each country given the high number of parameters to be assessed.

Not being satisfied with the results obtained while assessing the individual equation for each country, we will now develop an alternative model to that of the uniformity tests which we applied in section (5.2).

5.2 Developing a panel data model

The model we are going to develop is a one-factor panel model generally expressed by the equation:

$$y_{it} = g\left(x_{it}\beta_i + c_i\right) + E_{it} \qquad (8)$$

where x_{it} is a $1 \times K$ order matrix of explanatory variables, $i = 1...N$, $t = 1...T$.

N refers to the number of individuals (in our case N is CEMAC countries) and T, the number of periods.

[25] In theory, inflation constitutes a threat to monetary stability, and maintaining a low and relatively stable level of inflation seems to be the aim of many Central banks including that of CEMAC. This effect could however be justified as we indicated earlier (4.3.2) by a low level of inflation (0.76 on average with a standard deviation of 2.06 over the period under review).

c_i, $i = 1...N$ represent inobserved individual effects.
E_{it} represent the terms of supposedly independent and identically distributed (i.i.d) errors.

The application of this assessment technique is done using the hypothesis that the individuals put together have common characteristics (similar reaction to the variables considered), even though they may possibly have peculiarities. Therefore, we suppose that the coefficients β_k, $k = 1…K$ are identical for all the countries and c_i, $i = 1...N$ are inobservable effects, that are specific to each country.

5.2.1 Fixed individual effects or random individual effects

The assessment method of this model entails that it should first be determined whether these inobservable individual effects are random or fixed. Actually, choosing one of the models (with random effects or fixed effects) is guided by the assuption that is made on the correlation between the explanatory variables (x_{it}) and the individual effects (c_i).

In the literature review, the Hausman test is generally used to choose a model with random or fixed individual effects by comparing the indicators obtained in the two cases. The most obvious hypothesis is to assume the random effects. Assuming the random individual effects could find justification in the fact that not all the variables that can be used to explain the interest variable are taken into account (case of omitted variables) (op.cit [17]). This test is based on Fisher's statistics, with the null hypothesis being the equality of the coefficients obtained by the random and fixed individual effects models. With this test, we were able to validate the choice of a random individual effects model ($p - value = 0.36 > 0.05$).

5.2.2 Assessing and interpreting the model

The results of the assessment of this model are presented in the table below. The model is globally significant at 5%, the coefficients of the model are almost all significant at this threshold. The contribution of individual effects to the variance of errors is nill ($\sigma_u \approx 0$ and $\rho = 0$); which does not exactly correspond to the expectations following the results obtained during the uniformity test. The average probability of the deterioration of the CEMAC banking system is estimated at 0.29. This probability is calculated by taking into account the average levels of the explanatory variables used. The marginal effects of these variables will later be interpreted in relation to this reference position.

The model reveals that claims over the private sector for a particular period, have a positive impact on the probability of deterioration of the banking system for the following period. Therefore, a 1% increase in claims over the private sector in relation to their average value will lead to a 12% increase in the probability of deterioration of the banking system when compared to the reference risk, during the following period.

The risk of deterioration of the banking system is equally an increasing function of foreign direct investments (FDIs) and the combined trend of credits to the private sector and exports. This means that an increase in FDIs will lead to an increase in the risk of failure of the banking system, and a combined increase in credits to the private sector and exports. Thus, an average 1%

increase in FDIs will lead to a 0.18% increase in risk of deterioration; a 1% joint increase in credits to the private sector and exports will lead to a 0.76% increase in the deterioration risk.

The risk of deterioration of the banking system is reduced by owners' equity, exchange rate variations and inflation. Therefore, a 1% increase in the internal resources of the banking system will reduce its deterioration probability by 14.78%; a 1% increase in the exchange rate will reduce the risk of deterioration of the banking system by 0.07%; finally, a 1% increase in the inflation rate will reduce the probability of failure of the banking system by 0.32%.

5.3 Developing a common model for all the countries

This assessment method supposes that all the data is got using the same generating process. The assessment is thus made using data that has been collated irrespective of countries. It was done on the assumption that the error distribution is that of the logistic law[26]. On the whole, the model is significant at 1% and presents a reclassification power of about 72%. We realised that the coefficients obtained are identical to those obtained by assessment through panel data, thereby confirming the results obtained by the assessment using panel data, especially with regard to the nullity of inobservable individual effects noticed during the assessment.

These two models would thus entail perfect homogeneity between CEMAC countries in terms of variables considered. This seems possible with CEMAC, although it is contrary to the results obtained during the uniformity tests procedure.

[26] Generally, the choice is made between a probit model and a logit model. We came to this conclusion by using the AIC and BIC information criteria, which considers the model having the smallest criterion value as the best

Conclusion

The aim of this study is to provide the regulator of the banking system in the CEMAC region with a limited number of macro-prudential monitoring indicators in order to enhance the efficiency of the supervision of the banking system, through permanent monitoring of the dynamics of its weakness, and reduce its costs. To this end, we:

- Started by presenting the concept of macro-prudential monitoring which sees the monitoring of the system from a standpoint different from that of micro-prudential monitoring which was hitherto used by central bank managers. The macroprudential approach pays particular attention to the factors that make a financial system vulnerable and the interaction between macroenomic trends and financial stability, while the micro-prudential approach seeks to protect clients' deposits by assessing the solvency of each bank.

- And then, we presented the theoretical analytical framework by defining the concepts of weakness and deterioration. Through the application of this theoretical framework, we were later able to develop an econometric model that could be used to identify the indicators which can be used to predict a possible deterioration in the situation of the banking system.

- At the end of this analysis, it emerges that the regulator needs to pay particular attention to six variables, coming from all the macroeconomic variables, all the aggregate microprudential variables, and from the combination of these two. Thus, from a reference situation defined by the average level of model variables and a 29.1% risk of deterioration, a 1% GDP increase in claims over the private sector would lead to a 12.1% increase in the risk of deterioration of the banking system. While a 1% increase in the internal resources of the banking system as a percentage of total assets, would lead to a 14.8% reduction in this risk. These two variables stand out from the rest through the magnitude of their impact on the risk of deterioration of the CEMAC banking system.

With this study, we were able to identify a set of aggregate micro-prudential variables, macro-prudential variables and other variables drawn from a combination of micro-macro indicators, which can be used to predict a deteriorating situation in the CEMAC banking system. By determining the marginal effects of each of the variables on the probability of deterioration of the banking system, we were able to establish a hierarchy of variables, with regard to the importance we think the regulator should attach to them. With repeated use, this forecasting model could easily be automated such that at any one time it can readily give the regulator the probability of deterioration of the banking system. In fact, the marginal effects of the model variables could be assessed as of the current situation of banking system, that is, on the date t[27]. With this, once the values of the model variables have been found in t+1, we can find the probability of deterioration in the system for that date. Thus, such a mechanism will be used not only to monitor the evolution of the banking system but also to simulate the scenarios of situational changes and observe their repercussions on the stability of the baking system.

[27] It should be recalled that the abovementioned marginal effects (5.2.2) were calculated using the point average over the period under review and could thus be used for all dates.

The main shortcoming of this study is in the number of variables initially taken into account. The cummulative marginal effect of model variables which have a positive impact on the probability of deterioration is only about 14% while that of variables with a negative impact is about 18%. Several other macroeconomic variables on which we did not have any data over the period under review, could be included in the analysis, and among them, some could even turn out to be important for predicting the deterioration of the banking system. Moreover, the model does not take into account some characteristics that are specific to the banking system which could be considered as qualitative variables, especially those relating to regulation and structuring of the system.

Having in mind the abovementioned observations and considering the dynamism of the economy of the sub-region, we recommend that this study should be repeated, this time with a broader database to verify the accuracy of the results obtained, and updated on a regular basis in order to identify new warning variables and eliminate those which may become unrealiable in their forecasts.

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