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André Arnaud Enguene *

* Faculty of Science and Economic Management, University of Yaoundé II, Soa, Cameroon

E-mail: engueneandre@yahoo.com

Minimum Capital Requirements for Banks and the Financing of the Economies of the Economic and Monetary Community of Central Africa[1]

Abstract: This article analyses the impact of minimum bank capital on the financing of economies of the Economic and Monetary Community of Central Africa over the period 1998-2020, based on data from the Bank of Central African States and the annual reports and bulletins of the Banking Commission of Central Africa. To do this, we analysed the impact of minimum bank capital requirements on the real cost of credit, the term structure of credit and on economic agents with financing needs. We used a panel VAR specification estimated using the Generalised Method of Moments and impulse response function analysis based on Monte Carlo simulations to arrive at two main results: minimum bank capital reduces the cost of credit and increases the economy's credit level. The conclusion is that regulators would benefit from encouraging credit institutions to increase the current level of bank capital in order to benefit from the positive effects of minimum bank capital.

Keywords: financing of the economy, GMM, minimum bank capital, Monte Carlo, PVAR.

JEL Classification: E58, G21, G24.

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Introduction

Following the global financial crisis in 2008, the authorities introduced macroprudential policies in banking regulation, with capital buffers as one of the main tools. These buffers are in addition to the minimum capital requirement of 8% (Pillar 1) and aim to strengthen banks' resilience and cover potential losses related to cyclical risks. They also allow banks to maintain their capital capacity to support lending in difficult times. Capital buffers thus play a crucial role in mitigating economic cycles by absorbing losses and facilitating the financing of the real economy. However, recent regulatory developments may limit the use of banks' accumulated buffers (Pfeifer, 2023).

Work on banking regulation has received renewed attention, particularly with the introduction of the Basel Accord. Basel I is a fundamental element of international banking regulation, as each risk must be covered by a certain amount of capital to ensure the overall safety of the market and minimise systemic risks. Basel II, on the other hand, aims to harmonise the rules on banks' capital requirements. Pillar 2 of these rules covers minimum capital requirements. In addition, in response to the financial crisis of 2007/2008 and even the sovereign debt crisis in 2010, international regulators introduced Basel III. These new international banking regulations aim to strengthen capital requirements, particularly with regard to the ownership of bank capital. Basel III has put the issue of bank capital back on the agenda, and its importance is attracting increasing attention from researchers and financial professionals. Bank capital is derived from two complementary concepts: "economic capital" and "regulatory capital". The purpose of a supervisor setting regulatory capital is to ensure the soundness and stability of individual banking institutions and the banking system as a whole (Tiesset and Troussard, 2005). As Tiesset and Troussard indicate, it is a collective measure that applies to all market participants, while economic capital, on the other hand, is an individual measure designed to take full account of risks and is defined by each credit institution to measure each type of risk (). These two concepts are approximated by ratios, whose compliance is part of financial governance, the challenge being to protect customers' deposits without hindering banking intermediation (Noumba and Enguene, 2022). Bank capital represents own funds that a bank can use to finance what it has not borrowed. According to Mishkin (2010), "banks need to make decisions about the amount of bank capital they should hold for three reasons. First, bank capital is used to prevent bank failures. Second, the amount of bank capital affects the return to the bank's shareholders. Third, a minimum amount of capital (minimum regulatory capital) is required by supervisors. There are two opposing theories in modern finance about the importance or otherwise of bank capital. On the one hand, according to the bank lobbying theory, the requirement to hold bank capital reduces the resources that banks can allocate to financing economic activity and development. For the proponents of this theory, ceteris paribus, one 'franc' of bank capital is one 'franc' less to keep the economy going.

However, Osborne, Fuertes, and Milne (2017) point out that there are several virtues to holding large amounts of bank capital. Miles, Yang, and Marcheggiano (2013) go in the same direction when they write: "A financial institution with more bank capital has more financial resources to lend to economic agents in need of financing (...)". Thus, bank capital seems to have a place in bank financing of the economy.

On the other hand, the second trend brings together those who advocate the introduction of higher bank capital thresholds in line with the decisions taken during the implementation of Basel III. For the proponents of the second view, there are several virtues to holding high levels of bank capital. The Basel Committee insists that holding bank capital protects banks in times of distress. Some see this as "precautionary saving". For others, such as Miles et al. (2013), "capital is a source of funding". Ceteris paribus, "a financial institution with more bank capital has more financial resources to lend to economic agents in need of financing (...)".

The purpose of this study is to analyse the impact of bank capital requirements on the financing of the economies of countries of the Central African Economic and Monetary Community (CEMAC), where bank capital requirements remain relatively modest compared with the best capitalised banking systems on the continent (Tunisia, Nigeria, Algeria, Ghana, and South Africa). However, this situation has improved following a significant increase in the level of minimum bank capital for credit institutions compared with the pre-2009 period. Indeed, going back in time, we can see that the CEMAC countries did not have a uniform standard in terms of minimum bank capital. National legislation in Cameroon and Gabon set the minimum bank capital at one (1) billion CFA francs. On the other hand, this capital varied between 150 million and 300 million CFA francs for credit institutions in other countries. With the introduction of COBAC Regulation R-2009, which sets and harmonises the level of capital for credit institutions, this amount has been increased to 10 billion. We believe that this increase could affect the ability of credit institutions to ensure optimal financing of the economy.

Agents in need of resources can turn to the financial market to obtain the funds they need to finance their economic activities. However, this direct method of financing presupposes the existence of a large and dynamic financial market. Agents in need of financing can also go through banking institutions to obtain these funds. This is the indirect method of financing, in which banks lend funds saved by agents with excess liquidity. In CEMAC, the financial market is still in its infancy. The level of access to bank credit is one of the lowest in sub-Saharan Africa (Pérriou, 2014). For example, only about 3% of the total adult population has access to banking services. As a result, credit to the private sector in the CEMAC countries remains below the average for sub-Saharan Africa (Hugon, 2007). Despite this low level of financial inclusion of the population, there has been an increase in credit to the CEMAC economy, where credit granted to the private sector increased from 1,355 billion CFA francs in 2003 to 6,026 billion CFA francs in 2015 and is still slightly higher today (Noumba and Enguene, 2019). Overall, an analysis by maturity of the outstanding loans granted to the economy (public and private sectors) in recent years shows a renewed interest in financing investment in the CEMAC compared with the pre-2009 period.

In short, the main objective of any monetary and financial system is to help finance the economy and accelerate the pace of development in the countries concerned. Given the extreme weakness of the CEMAC stock market, banks must be able to convert short resources into long resources in order to solve the thorny problem of financing the economies of the countries concerned. To do so, however, they must comply with certain prudential requirements, such as the maintenance of a minimum level of capital. The operation of the banking system must necessarily be based on the principles of stability, soundness, and liquidity. It must also preserve the profitability of banks. Thus, the problem raised in this article is that of the financing deficit of the economy that could result from the low level of minimum bank capital of credit institutions in the CEMAC. The question that concerns us is whether the significant increase in minimum bank capital has had a significant impact on bank financing in the economies of the countries involved.

The main objective of this article is to assess the impact of minimum bank capital requirements on the different layers of financing in the CEMAC economies (real cost of credit, term structure of credit, and credit to economic agents in need of financing). The aim is to assess this impact on a triple dimension of the financing of the economy, namely: the real cost of credit, the term structure of credit, and credit to economic agents in need of financing. We hypothesise that the minimum bank capital requirement has a positive and significant effect on the financing of the economy. Specifically, minimum bank capital reduces the real cost of credit, increases short-, medium-, and long-term credit, and has a positive effect on credit to the economy. The remainder of the article is based on the following points arranged as follows: Section two provides a selective review of the theoretical and empirical foundations. Section three presents the methodological approach of the paper. The results are presented and analysed in Section 4. Section five concludes with some policy recommendations.

1. Theoretical and empirical foundations of the study

1.1. Theoretical review

Prudential regulation is now at the heart of the regulatory control of financial institutions. It is essentially based on the definition of prudential ratios, the key element of which is the solvency ratio (Cooke ratio in 1988). The first theoretical contributions to the analysis of prudential regulation had difficulty integrating the specific characteristics of banks in relation to the financial market (theory of preference over states) and in relation to other financial intermediaries (theory of portfolio choice). More recent approaches, known as "optimal regulation", are beginning to incorporate the contributions of information economics and, in particular, certain information asymmetries that are essential for understanding the banking economy. However, the debate has undoubtedly evolved by focusing on the theory of optimising bank funding in relation to minimum capital requirements for banks.

Regulations on minimum capital requirements for credit institutions affect the level and quality of bank loans needed to finance an economy (Conseil d'Analyse Économique, 2012). These regulations change the volume of lending or borrowing by banks. This has a more or less moderate impact on interest rate variables, depending on the role of the banking system in financing the economy. Indeed, credit institutions react differently depending on the level of minimum bank capital required to meet the credit needs of different economic agents. The purpose of this section is to show, on the basis of existing theoretical and empirical work, the effect of the capital of credit institutions on the financing of the economy. There are two opposing theories in the analysis of the effect of bank capital on the financing of the economy. These are the portfolio choice theory and the government preference theory.

Proponents of portfolio choice theory conclude that bank capital has a positive effect on the financing of the economy. Theoretical studies in this vein focus on the level of bank capital in bank lending decisions. Thus, regulatory developments tend to strengthen the role of bank capital in financing the economy. The effect of bank capital on bank lending appears to be a crucial factor in the link between "financial conditions and real activity." (Levieuge, 2005). The role of bank capital in the transmission of monetary policy is exercised according to the mechanisms described in the theories of bank lending and credit. It is also exercised according to the schemes presented in the bank capital channel theory, the portfolio choice theory, and the government preference theory. These theories have provided the basis for existing empirical studies.

1.2. Empirical review

Empirically, the functioning of the bank lending channel depends on the existence of bank credit as the only means of financing economic agents with financing needs. Credit institutions are obliged to raise capital exclusively through the collection of bank deposits. However, the operation of the bank capital channel depends on two factors. First, this mechanism depends on the existence of firms whose only source of financing is bank credit. Second, this mechanism assumes that credit institutions have difficulties in raising capital due to information asymmetries. Van Den Heuvel and Skander (2008), for example, analyse the role of bank loans in the transmission of monetary policy, taking into account the regulation of bank capital levels. They develop a dynamic methodology for managing a credit institution's assets and liabilities. This model incorporates bank capital requirements based on uncertainty and an imperfect capital market for credit institutions. The authors take into account "maturity mismatches in credit institutions' balance sheets". They propose a bank capital channel through which monetary policy affects bank lending via its effects on credit institutions' capital. However, this mechanism is not based on the specific role of bank reserves linked to the bank lending channel.

Furthermore, a study by Van Den Heuvel (2002) suggests that a channel independent of monetary policy gives the bank capital channel an important role in the financing of economic agents. According to this author, a shock to the bank capital channel affects the real economy through the bank credit channel. This author believes that bank capital plays a role in transmitting shocks from the financial sector to the real economy. Similarly, Woo (2003) tests the hypothesis of the effect of low capital levels on the activity of credit institutions in Japan. Indeed, the low level of bank capital seems to have limited bank financing of the Japanese economy in the 1990s. The author uses a sample of credit institutions representing about 90% of the assets of the banking system. His analysis focuses on the dynamics between changes in bank balance sheet items and bank capital. The results of this study confirm the credit rationing hypothesis. This credit rationing is mainly due to a deterioration in bank capital of the credit institutions. There is a positive and statistically significant correlation between the bank capital ratio and the growth of bank lending. In addition, a similar study was carried out by Bernanke and Lown (1991) in the US at a time when bank capital requirements were being tightened. The regulatory requirement for bank capital is based on the level of risk taken by credit institutions. Since the introduction of the Cooke ratio in 1988, it has been implemented by several regulators. This requirement is characterised by the tightening of the provisioning criteria for probable losses on bank loans. In the US, the law on early enforcement against failing institutions was introduced (Appendix, Table 7). Since then, the introduction of a risk-based regulatory capital regime has increased the number of credit institutions with capital below the minimum requirement. The results of this study confirm the hypothesis of a credit crunch. According to the authors, "It is indeed the pressure on bank capital levels that induces a significant shift to the left of the bank credit supply curve".

In addition, Altunbas, Carbo, Gardener, and Molyneux (2007) use bank balance sheet data to assess the level of bank lending following the change in bank capital ratios between 1991 and 1999. These authors classify credit institutions according to their size in terms of bank capital. In their study, these authors want to know whether the level of bank capital has a significant impact on the bank lending channel. They use a panel methodology for their empirical analysis. The results of this study show that, in the case of banking systems in the European Union (EU), "banks with low levels of bank capital tend to reduce the level of bank lending". However, these results vary from country to country. In France, Germany, Italy, and Spain, for example, there is evidence of a bank lending channel. In other words, the level of bank capital affects the level of bank lending. Gambacorta and Mistrulli (2004) examine possible cross-sectional differences in the response of bank lending to the bank capital shock and to the GDP shock according to the capital levels of European banks. Their results show that "well-capitalised banks provide adequate financing to firms". Their study confirms the idea that "the bank lending channel hypothesis is a function of the capital endowment of credit institutions". The authors also show that bank lending responds differently to a monetary policy shock. According to them, this shock is a function of the level of maturity and transformation costs of credit institutions. Similarly, Liu and Wilson (2010) analyse the link between bank capital and the transmission of monetary policy in Japan. For the authors of this study, the analysis of the bank capital channel requires an analysis of its impact on the financing of the economy. They therefore use the empirical model developed by Kashyap, Stein and Hanson (2010). As predicted by the bank capital channel hypothesis, these authors find that a tightening of monetary policy has a greater impact on the least capitalised credit institutions. Similarly, credit institutions with higher maturity transformation costs contract bank loans following a tightening of monetary policy. Thus, the supply of credit by highly capitalised financial institutions does not seem to depend on the business cycle. The results of this study tell us, first, that "it is important for monetary policy to take into account the regulation of bank capital and its effect on the economy". Secondly, credit institutions need to be well capitalised in order to reduce the procyclical effect. Similarly, the study by Pfeifer (2023) examines the potential use of capital buffers to absorb losses in the Czech banking sector and analyses their impact on the lending capacity of the real economy. This study provides important insights for policy makers and financial regulators. Indeed, if capital buffers are effective in absorbing losses without compromising lending capacity, this could strengthen the stability of the financial system and support the real economy.

Finally, Levieuge's (2005) study is based on the theory of the "heart of the bank capital channel", in this case the evolution of the link between "equity and credit supply". The author emphasises the importance of financial health of credit institutions for their lending behaviour. For him, Scandinavian and Japanese banking institutions provide convincing evidence for this analysis, as institutions close to (or already below) the required capitalization thresholds tend either to ration bank lending or impose stricter lending conditions. Thus, confirming the theory of the bank capital channel, it is (in particular) the small credit institutions that have more difficulties in recapitalizing. It is these same credit institutions that are at the root of the decline in bank lending.

However, other studies conclude that the effect of bank capital on the financing of the economy is negative. For example, Brun, Fraisse, and Thesmar (2013) analyse the real effects of capital requirements on the distribution of credit in France with reference to the Basel I and Basel II agreements. In their analyses, they exploit the double variation of bank capital to empirically estimate the semi-elasticity of credit to bank capital requirements. They use a methodology that allows them to correct for credit demand effects at the level of the firm and credit supply effects at the level of the credit institution. The authors find that "an additional one percentage point of bank capital requirement reduces the allocation of credit by 10%". Similarly, Dietsch, Düllmann, Fraisse, Koziol and Ott (2016) analyse the impact of capital requirements on the distribution of credit to SMEs in France. These authors highlight the underestimation of credit risk in the formulas used to calculate banks' regulatory capital. They assess the impact of regulatory capital requirements on the corporate loan portfolios of the six largest banking groups operating in France. They compare the economic capital requirements measured by a multi-factor model with a portfolio credit risk model. This model takes into account the heterogeneity of companies seeking credit from banks by distinguishing them by size. The results are twofold. The first is that the formulas used to calculate regulatory capital do not underestimate the credit risk of banks' loan portfolios, as regulatory capital requirements for banks are often higher than economic capital requirements for banks in the vast majority of cases. The second finding of this study is that bank regulatory capital models overestimate the sensitivity of borrowers to the business cycle. Thus, the impact of economic capital requirements on lending to the economy is attenuated by borrower heterogeneity.

Furthermore, the study by Veselinovič, Fabijan and Vadnjal (2023) shows that capital adequacy of the banking sector in the Economic and Monetary Union (EMU) affects credit growth as well as the non-financial sector activity. The results of this study show a dependence between bank capital adequacy and credit growth in the euro area, covering the period from the first quarter of 1999 to the first quarter of 2022. The correlation coefficient of 0.48 indicates an average positive relationship between these variables. Moreover, more than 23% of the variability of loans can be explained by the variability of capital adequacy. However, the authors observe two different and somewhat controversial dynamics with respect to loan growth and capital adequacy over the study period. A simple linear regression during the crisis revealed a relatively high negative correlation of around -0.6. Thus, the sub-hypothesis that higher capital adequacy leads to negative loan growth was confirmed for the crisis period.

In short, the above analyses do not remove any ambiguity regarding the impact of bank capitalization on the supply of bank credit or on the financing of the economy. Generally speaking, the relationship between bank capital and the supply of credit would depend on the regulatory requirements in this area (maintenance of regulatory capital). What conclusions can be drawn from the analysis of the data for the CEMAC countries?

2. Methodology

We present the specified model, the data sources, and the variables involved before describing the estimation method used.

2.1. Presentation of the basic empirical model and model selection procedure

2.1.1. Presentation of the empirical model

Given the geographical scope of the study (the six CEMAC countries), we use a dynamic panel specification. Our choice is justified by arguments proposed in particular by Collard and Fève (2008), Gossé and Guillaumin (2013), and Abrigo and Love (2016). We therefore consider a panel VAR model with k variables of order p, as proposed by Abrigo and Love (2015, 2016). This model is specified in a specific fixed effects panel, represented by the following system of linear equations:

$$Y_{\cdot it} = Y_{\cdot it-1} A_1 + Y_{\cdot it-2} A_2 + \cdots + Y_{\cdot it-p+1} A_{\cdot P-1} + Y_{\cdot it-p} A_{\cdot p} + X_{\cdot it} B. + \mu_{it} + \xi_{it} \quad (1)$$
$$i \in \{1, 2, \ldots, N\}, t \in \{1, 2, \ldots, \quad T_i\}$$

where $Y.it$ is a vector (1*k) of dependent variables; $X.\ it$ is a vector (1*l) of exogenous variables; $\mu it\ et\ \xi it$ are the vectors (1*k) of dependent variables of fixed and specific effects and idiosyncratic errors respectively. The (k*k) matrices $A.1$, $A.2$,..., $A.p$ and the (l*k) matrix B. are parameters to be estimated. Abrigo and Love (2015) estimate that innovations have the following properties: for any $t > s$. Model (1) in matrix form may be more appropriate in this study. In fact, we have divided financing into a triple dimension, namely: the cost dimension, represented by the total effective interest rate (TEG); the structural dimension, by the level of short-term (CCT), medium-term (CMT) and long-term (CLT) loans; and the agent dimension, based on the level of loans granted to the economy (CE), to public enterprises (CEPU), to the private sector (CSP) and to non-residents (CNR). Formally, based on equation (1), the different specifications of the PVAR (panel vector autoregression) models are as follows:

Model 1: Impact of minimum bank capital requirements on the real cost of credit

$$TEG_{it} = \gamma_{10} + \gamma_{11} TEG_{t-1} + \gamma_{12} CBM_{it-1} + \mu_{1i} + \vartheta_{1t} + \xi_{1it} \quad (2)$$

$$CBM_{it} = \gamma_{20} + \gamma_{21} TEG_{t-1} + \gamma_{22} CBM_{it-1} + \mu_{2i} + \vartheta_{2t} + \xi_{2it} \quad (3)$$

Model 2: Impact of bank capital requirements on the maturity structure of loans

$$CCT_{it} = \alpha_{10} + \alpha_{11} CCT_{it-1} + \alpha_{12} CBM_{it-1} + \alpha_{13} CMT_{it-1} + \alpha_{14} CLT_{it-1} + \mu_{1i} + \vartheta_{1t} + \xi_{1it} \quad (4)$$

$$CMT_{it} = \alpha_{20} + \alpha_{21} CCT_{it-1} + \alpha_{22} CBM_{it-1} + \alpha_{23} CMT_{it-1} + \alpha_{24} CLT_{it-1} + \mu_{2i} + \vartheta_{2t} + \xi_{2it} \quad (5)$$

$$CLT_{it} = \alpha_{30} + \alpha_{31} CCT_{it-1} + \alpha_{32} CBM_{it-1} + \alpha_{33} CMT_{it-1} + \alpha_{34} CLT_{it-1} + \mu_{3i} + \vartheta_{3t} + \xi_{3it} \quad (6)$$

Model 3: Impact of minimum bank capital requirements on economic agents with financing needs

$$CE_{it} = \beta_{10} + \beta_{11} CE_{it-1} + \beta_{12} CBM_{it-1} + \beta_{13} CEPU_{it-1} + \beta_{12} CSP_{it-1} + \beta_{15} CNR_{it-1} + \mu_{1i} + \vartheta_{1t} + \xi_{1it} \quad (7)$$

$$CEPU_{it} = \beta_{20} + \beta_{21} CE_{it-1} + \beta_{22} CBM_{it-1} + \beta_{23} CEPU_{it-1} + \beta_{24} CSP_{it-1} + \beta_{25} CNR_{it-1} + \mu_{2i} + \vartheta_{2t} + \xi_{2it} \quad (8)$$

$$CSP_{it} = \beta_{30} + \beta_{31} CE_{it-1} + \beta_{32} CBM_{it-1} + \beta_{33} CEPU_{it-1} + \beta_{34} CSP_{it-1} + \beta_{35} CNR_{it-1} + \mu_{3i} + \vartheta_{3t} + \xi_{3it} \quad (9)$$

$$CNR_{it} = \beta_{40} + \beta_{41} CE_{it-1} + \beta_{42} CBM_{it-1} + \beta_{43} CEPU_{it-1} + \beta_{44} CSP_{it-1} + \beta_{45} CNR_{it-1} + \mu_{4i} + \vartheta_{4t} + \xi_{4it} \quad (10)$$

Where $i = 1 \ldots 6$; t represents the time horizon (1998 - 2020) $et\ j = 1 \ldots 6$.

Where $\mu ji, \vartheta jt$ et ξjit represent country-specific effects, time-specific effects and idiosyncratic errors respectively.

2.1.2. Model selection

The analysis of a PVAR requires the choice of the optimal lag order. The specification of the panel VAR model must satisfy certain assumptions. Andrews and Lu (2001) propose selection criteria for these models. These criteria are based on Hansen's J-test (Hansen, 1982). This test indicates whether the model is over-identified. According to Roodman (2009), a basic assumption for the GMM estimator is that the instruments are exogenous. The test can be applied to one-step or two-step GMM estimators. According to Andrews and Lu, MMSCs are analogous to various model selection criteria based on the maximum likelihood method commonly used in the literature, namely Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), and Hannan-Quinn Information Criteria (HQIC). Thus, Andrews and Lu, referring to Sigmund, Ferstl and Untekofler (2017), recommend MMSC-BIC (Bayesian information criteria) or MMSC-HQIC (Hannan-Quinn information criteria). According to them, MMSC-AIC (Akaike Information Criteria) does not meet their consistency criterion, as it is likely to be positive and asymptotic.

In addition, the standard stability condition for the coefficients of the panel VAR model is based on the moduli of each eigenvalue of the estimated model. Lütkepohl (2006) shows that a panel VAR model is stable if all the moduli of the associated matrix are strictly less than one. The stability of the panel VAR model implies that the model is invertible and has a moving average vector of infinite order.

2.2. Presentation of the estimation method and analysis of results

2.2.1. Presentation of estimation method

The parameters of the above models can be estimated jointly or independently of the fixed effects after some transformations using equation-by-equation ordinary least squares (OLS). However, the results are biased by the lagged endogenous variable on the right-hand side of the equation. To solve this problem, Sigmund, Ferstl and Unterkofler (2017) and Abrigo and Love (2015) recommend the use of GMM estimators. Indeed, several estimators based on the GMM method have been proposed to compute the estimates of equation (1) above, especially when T is fixed and N is large. If we assume that the errors are uncorrelated, the estimation of equation (1) from its first difference transformation can be done by instrumenting the variables in differences and levels from previous periods (Anderson and Hsiao, 1982). However, Abrigo and Love point to a problem with this estimator as the first difference transformation of the equation increases the variance in an unbalanced panel. For example, if some data are not available, the first difference equation for periods t and t-1 will have missing data. In addition, the lag order of a PVAR increases the number of periods required for each panel. For example, for a second-order PVAR, level instruments require that we observe each panel.

In addition, Arellano and Bover (1995) propose an orthogonal deviation as an alternative to transforming the equation into a first difference. Instead of using deviations from past observations, they subtract the mean of all available future observations, thereby minimising data loss. Potentially, only recent observations are not used in the estimation, as past observations are not included in this transformation but remain valid instruments. For example, in a second-order PVAR, only observations with a lag are needed to have valid instruments in the level.

2.2.2. Method of analysing results

The empirical literature shows that there are two main methods for analysing the results of estimating a PVAR. These are impulse response function analyses and variance decomposition analyses. The orthogonal impulse responses are computed using the procedures of Lütkepohl (2006) and Pfaff (2008) Impulse response analysis for a PVAR is concerned with the responses of one (endogenous) variable to a stimulus from another (endogenous) variable. This idea can be formalised by first deriving the so-called PVMA-X representation of the process represented by PVAR-X(1) (Lütkepohl, 1990). GMM estimators also provide structural analysis functions for PVAR models, which are orthogonal impulse response functions (Lütkepohl, 2006); generalised impulse response functions (Persaran and Shin, 1998); and forecast error variance decomposition. The matrix $\bar{\boldsymbol{A}}$ below is strictly less than 1. This matrix, according to Persaran and Shin (1998), is as follows:

$$\bar{A} = \begin{pmatrix} A_1 & A_2 \cdots & A_p & A_{p-1} \\ I_k & 0_k & \ldots 0_k & 0_k \\ 0_k & I_k & \ldots 0_k & 0_k \\ \vdots & \vdots\ddots & \vdots & \vdots \\ 0_k & 0_k & \ldots I_k & 0_k \end{pmatrix} \tag{11}$$

This representation provides a known interpretation of the estimated impulse response functions and the variance decomposition of the prediction error. The simple impulse response functions Φ_i can be calculated by rewriting the above matrix as a vector moving average (VMA), where les Φ_i are the parameters of the moving average vector, as follows:

$$\Phi_i = \begin{cases} I_k & i = 0 \\ \sum_{j=1}^{i} \Phi_{t-j} A_j, & i = 1, 2, \ldots \end{cases} \tag{12}$$

However, the simple impulse response does not provide a causal interpretation because ξ_{it} innovations are simultaneously correlated, and a shock to one variable is likely to be accompanied by shocks to other variables (Karame, 2012). Suppose we have a matrix P such that PP'=∑. Then the matrix P can be used to orthogonalise innovations as $\xi_{it}P^{-1}$ and to transform the parameters of the VMA process into orthogonalised impulse responses $P\Phi_i$. The P matrix effectively imposes constraints on the system of dynamic equations. Sims (1980) proposes the Cholesky decomposition of ∑. to impose a recursive structure on the VAR model. However, the decomposition is not unique, but depends on the order of the variables in the matrix ∑.

In addition, the confidence interval of the impulse response functions can be derived analytically as a function of the asymptotic distribution of the PVAR parameters and the variance-covariance matrix. Alternatively, the confidence interval can be estimated using Monte Carlo simulations to correct for forecasting errors and bootstrap resampling methods. In this study, our impulse response functions are based on Monte Carlo simulations. In addition, the variance of the prediction error can be expressed as:

$$Y_{\cdot it+h} - E[Y_{\cdot it+h}] = \sum_{i=0}^{h-1} \xi_{i(t+h-i)} \Phi_i \tag{13}$$

Where $Y_{\cdot it+h}$ is the vector observed at time $t+h$ and $E[Y_{\cdot it+h}]$ is the vector predicted in advance at time t. As with the impulse response functions, we orthogonalise the shocks using the P matrix to isolate the contribution of each variable to the variance of the forecast error. The orthogonalized shocks $\xi_{it}P'$ have a covariance matrix I_k, that allows a quick decomposition of the variance of the forecast error. Specifically, the contribution of a variable m to the forecast error variance of variable n can be calculated as follows:

$$\sum_{i=0}^{h-1} \theta_{m,n}^2 = \sum_{i=1}^{h-1} (i_n' P \Phi_i i_m)^2 \tag{14}$$

Where i_m is the mth column of I_k. In practice, the contributions are often normalised with respect to the variance of the forecast error of the variable n as:

$$\sum_{i=0}^{h-1} \theta_n^2 = \sum_{i=1}^{h-1} i_n' \Phi_i' \sum \Phi_i i_n \tag{15}$$

This equation is similar to that used to compute impulse response functions. Confidence intervals can be derived analytically or estimated using various resampling techniques. In summary, the above analyses allow us to present the results of our various estimations in the next section.

2.3. Data and presentation of variables

2.3.1. Data

The empirical analysis of our variables is based on annual data over the period 1996-2020. This period allows us to see the ex-post and ex-ante effects of the minimum bank capital on the financing of the economy before its harmonisation at the threshold of 10 billion CFA francs in 2009. The data are mainly taken from the annual reports and bulletins of the Commission Bancaire de l'Afrique Centrale (COBAC) for data relating to the banking sector (minimum bank capital, loans to the economy, the private sector, the public sector and non-residents; the same applies to short, medium and long-term loans). On the other hand, data on the overall effective rate come from the Bank of Central African States (BEAC) database.

The variables chosen for this study are justified by the availability of data as well as by their relevance, since this study seems to be one of the first, if not the only one, to be able to subdivide the financing of the economy into a triple dimension, namely: the cost dimension (TEG), the agent dimension (CE, CSP, CEPU and CNR) and the time dimension (CCT, CMT and CLT). Moreover, these variables are important to show that minimum bank capital reduces the cost of credit borne by economic agents in need of financing. In addition, bank capital also modifies the time dimension of loans and economic agents in need of financing and can therefore help to solve the problem of excess bank liquidity in the CEMAC.

2.3.2. Presentation of variables

Table (1) below provides a brief definition of the variables and data sources used.

Table 1: Definition of variables and data sources

Variable	Definition	Source
CBM (minimum bank capital), 10^6	Minimum bank capital is the capital requirement for the opening of a credit institution.	COBAC
CCT (short-term credit), 10^6	Current loans are defined as those maturing in less than two years.	COBAC
CMT (medium-term credit), 10^6	Medium term loans are defined as those maturing between 2 and 7 years.	COBAC
CLT (long-term credit, 10^6	Long-term loans are loans with a maturity of more than 7 years.	COBAC
CSP (credit to the private sector), 10^6	Loans to the private sector are loans that are granted to private sector enterprises.	COBAC
CEPU (credit to public companies), 10^6	Loans to public enterprises are loans that are granted to public sector enterprises.	COBAC
CNR (credit to non-residents), 10^6	Loans to non-residents are defined as loans granted to economic agents located outside the CEMAC area.	COBAC
CE (credit to the economy), 10^6	Credit to the economy is the sum of all means of payment circulating in the economy over the course of a year.	COBAC
TEG (overall effective rate), %	The overall effective interest rate is the interest cost that is actually borne by the borrower.	BEAC

Source: Author

Models 1, 2 and 3 presented above consist of two types of variables: explained and explanatory variables. In addition, there is a lagged endogenous variable in each of these equations. In fact, each model is explained by the fact that the current variable is influenced by previous results for the same variable. This is because, in economic theory, deposits generate loans for some and loans generate deposits for others.

2.4. Descriptive statistical data

In this section we present the results of the descriptive analysis of our data. Table 2 below presents the descriptive statistics for the different variables. It can be seen that the average level of minimum bank capital for the CEMAC countries is around 53,006.32 million CFA francs. The minimum capital of CEMAC credit institutions also varies between 4,500 (CAR) and 176,520 (Gabon) million CFA francs.

In terms of the volume of loans by maturity, the average volume of long-term loans granted in the CEMAC is 18,866.66 million CFA francs, the average volume of short-term loans is 154,458.9 CFA francs and the average volume of medium-term loans is 252,242.2 CFA francs. In addition, the average amount of loans to economic agents in need of financing is 38,118.73 for loans to the economy, 28,720.72 for loans to public enterprises, 4,410.83 for the private sector, and 36,166.47 for non-residents.

Table 2: Descriptive statistics

Variable	Observation	Mean	Standard deviation	Minimum	Maximum
CBM (10^6 FCFA)	150	53,006.32	49,708.6	4,500	176,520
CLT (10^6 FCFA)	150	18,866.66	38,883.8	0	233,554
CMT (10^6 FCFA)	150	252,242.2	406,436.9	0	2,430,232
CCT (10^6 FCFA)	150	154,458.9	261,514.5	0	1,678,449
CE (10^6 FCFA)	150	38,118.73	99,930.26	1,045	681,209
CEPU (10^6 FCFA)	150	28,720.72	35,496.19	950	146,346
CSP (10^6 FCFA)	150	4,410.83	52,0547.4	37,643	2,276,497
CNR (10^6 FCFA)	150	36,166.47	56,601.63	124	345,289
TEG (%)	150	9,476404	3,654,649	1.07	16.46

Source: Author

Moreover, the average overall effective rate in the CEMAC zone during the period under review was 9.476%. This rate varied between 1.07% and 16.46%. In most cases, credit institutions in the CEMAC zone apply a policy of high interest rates in their lending operations. This result shows that bank loans are expensive in these economies.

In Table 2 above, we are only interested in the correlation between minimum bank capital and the different variables in our models (bold column). This table allows us to see the different relationships between the variables, as well as their level of significance at the 5% threshold. Thus, focusing only on the first column (bold column) of our table, we can see that there is a positive correlation between minimum bank capital and variables such as: short, medium and long-term loans; between minimum bank capital and loans to the economy, public enterprises, private enterprises, and non-residents. On the other hand, there is a negative correlation between minimum bank capital and the overall effective rate. This can be interpreted in two ways. On the one hand, minimum bank capital has a positive effect on the amount of loans by maturity (short, medium and long-term loans) and on the amount of loans granted to loss-making economic agents (loans to the economy, loans to public enterprises, loans to the private sector and loans to non-residents). On the other hand, the level of minimum bank capital tends to reduce the real cost of credit borne by the borrower. Finally, all coefficients in the first column are significant at the 5% level.

In Table 3 below, stationary series in level are indicated (*) and stationary series in first difference are indicated (**). The Levin - Lin - Chu (LLC) and Im - Persaran - Shin (IPS) stationarity tests for the series are presented in Table 4. It should be noted that we have a balanced panel over 25 years. The results show that it is not possible to reject the null hypothesis. In other words, some series contain unit roots and the following series are assumed to be non-stationary in level (CLT, CMT, CCT, CE, CEPU, CSP and CNR). For this reason, the analysis could give erroneous results. We therefore used the Pedroni (1999, 2004) cointegration test, which is designed for non-stationary heterogeneous series (Table 5).

Table 3: Correlation matrix

	CBM	CLT	CMT	CCT	CE	CEPU	CSP	CNR	TEG
CBM	1.0000								
CLT	0.4288* 0.0000	1.0000							
CMT	0.5932* 0.0000	0.8809* 0.0000	1.0000						
CCT	0.5348* 0.0000	0.3605* 0.0001	0.5868* 0.0000	1.0000					
CE	0.6174* 0.0000	0.3443* 0.0002	0.4069* 0.0000	0.1525 0.1054	1.0000				
CEPU	0.4220* 0.0000	0.2208* 0.0182	0.4230* 0.0000	0.7736* 0.0000	0.1414 0.1335	1.0000			
CSP	0.8119* 0.0000	0.3393* 0.0002	0.5757* 0.0000	0.7482* 0.0000	0.3820* 0.0000	0.498* 0.0000	1.0000		
CNR	0.5557* 0.0000	0.2075* 0.0267	0.4702* 0.0000	0.870* 0.0000	0.923 0.3289	0.7706* 0.0000	0.8432* 0.0000	1.0000	
TEG	-0.22* 0.0000	-0.11 0.23666	-0.14* 0.0219	-024* 0.0092	-0.19* 0.0428	-0.28* 0.0019	-0.22* 0.0168	-0.24* 0.0082	1.0000

Note: The first line of the corresponding box gives us the correlation coefficient between two variables. The second line gives us the level of significance of the said correlation coefficient at the 5% threshold.

Source: Author

3. Analysis of the econometric results

In this section, we first present the stationarity and cointegration tests for the different variables and the choice of the optimal lag before presenting the estimation results.

Table 4: Stationarity test

Variables	Levin-Lin-Chu test		Im-Persaran-Shin test	
	In level	First difference	In level	First difference
	P-value	P-value	P-value	P-value
CBM*	0.08	0.028	0.166	0.00
CLT**	0.00	0.00	0.707	0.00
CMT**	0.10	0.00	0.27	0.00
CCT**	1.00	0.00	0.49	0.00
CE**	0.95	0.00	0.89	0.00
CEPU**	0.12	0.00	0.40	0.00
CSP**	0.39	0.00	0.92	0.00
CNR**	0.10	0.00	0.06	0.00
TEG*	0.00	0.00	0.00	0.00

Source : Author.

Table 5: Pedroni test of minimum bank capital

	CLT		CMT		CCT	
	Panel	group	Panel	Group	Panel	Group
v	0.9837		0.3833		0.3735	
rho	- 0.684	-0.3452	-0.6583	-0.2345	-0.6473	-0.4783
t	-0.7464	-0.4628	-0.8774	-0.6785	-0.5467	-0.4637
adf	-0.4567	-0.4755	-0.4251	-0.8747	-0.6583	-0.4637

Source: Author

From Table 5 above, and knowing that not all variables are stationary in level, we conducted the Pedroni (2004) cointegration test. This test is a residual-based cointegration test for panel data based on the null hypothesis that there is no cointegration with one or more non-stationary series. Pedroni (2004) provides seven (7) test statistics to test the null hypothesis of no cointegration with four panel statistics and three group statistics (Atangana Ondoa, 2019).

The first group contains the statistics along the internal dimension, while the second group averages the results of the test statistics by country, since the statistics do not diverge to negative infinity for each equation under the alternative hypothesis. All statistics lead us to accept the null hypothesis that there is no cointegrating relationship between minimum bank capital and the other variables. In other words, minimum bank capital explains the following variables CLT, CMT, CCT, CEPU, CE, CSP, CNR, TEG.

Table 6: Results of the Hansen test between CBM and TEG

Optimum delay	CD	J	J p-value	MBIC	MAIC	MQIC
1	-0.2020187	23.41389	0.0244107	**-28.86661**	-0.5861072	-11.90731
2	0.2240231	7.855753	0.4476861	-26.99792	-8.144247	-15.69172
3	0.390138	5.957944	0.2023111	-11.46889	-2.042056	-5.815791

Source: Author

Table 7: Results of the Hansen test between CBM, CLT, CMT and CCT

Optimum delay	CD	J	J p-value	MBIC	MAIC	MQIC
1	-12.43273	48.57493	0.4496733	**-160.5471**	-47.42507	-92.7098
2	-1.613978	39.86939	0.1599135	-99.54529	-24.13061	-54.32049
3	0.5410718	16.51101	0.4179001	-53.19633	-15.48899	-30.58393

Source: Author

Table 8: Results of the Hansen test between CBM, CE, CEPU, CSP and CNR

Optimum delay	CD	J	J p-value	MBIC	MAIC	MQIC
1	-16.94568	53.30722	0.4237062	**-172.5707**	-50.69278	-99.44286
2	-16.08933	36.08985	0.1709613	-89.8805	-21.91015	-49.09769
3	-0.3723227	33.98541	0.0012097	-22.48406	7.985412	-4.202109

Source: Author

Based on the three model selection criteria developed by Andrews and Lu (2001), in particular the coefficients of determination (CD), the first-order panel VAR is the optimal model (Tables 6, 7 and 8). In other words, the optimal lag is the first-order lag, as it has the smallest CD with the MBIC. The following tables show the Hansen J-test results for the three models.

In addition, we also minimised the Hansen J statistic, as it does not correct at first order for the degrees of freedom in the different MMSCs, following Andrews and Lu (2001). Based on the selection criteria, we fit our first-order PVAR models with the same instrument specification using the GMM estimator implemented by the PVAR models, following Abrigo and Love (2016).

3.1. Analysis of the results of the impact of minimum bank capital requirements on the financing of the economy

Regarding the analysis of the results, the estimation of the PVAR in the GMM allows us to obtain three results based on the models presented above.

First, Table 9 presents the results of the impact of the minimum bank capital on the TEG. The level of the minimum bank capital has a negative and significant effect on the real cost of credit borne by the borrower at the 1% threshold. We can say that the level of the minimum bank capital has a downward effect on the level of the total effective interest rate (this is the same result we found in the analysis of the correlation between the minimum bank capital and the TEG). It can be said that an increase in the level of minimum bank capital reduces the real cost of credit borne by the borrower.

Second, Table 9 below presents the results of the impact of the MBC on the maturity structure of loans. This table successively analyses the impact of the MBC on the level of short-term, medium-term and long-term loans. First, the MBC has a positive and significant impact on the level of long-term loans at the 1% threshold. Second, the MBC has a negative and significant impact on the level of medium-term loans. Third, at the 1% threshold, the minimum bank capital has a negative and significant effect on the level of short-term loans. In conclusion, the low level of minimum bank capital induces credit institutions not to grant loans. An increase in the level of minimum bank capital would encourage investment financing. In other words, if a banking institution has a high level of minimum bank capital, banks will grant more of the long-term loans needed to finance productive investment by entrepreneurs.

Table 9: Results of the estimation of the impact of the CBM on the TEG

	Variable	Coefficient	S.D	Z	p > |z|	[(95% confidence interval)]	
CBM	CBM L1.	-0.198	0.170	-1.17	0.243	-0.532	0.135
	TEG L1.	996.025	262.181	3.80	0.000***	482.160	1509.891
TEG	CBM L1.	-0.0025	0.000	-2.94	0.003***	-0.0004	-0.000
	TEG L1.	-0.3400	0.088	-3.83	0.000***	-0.513	-0.166

*** p<0.001 ; **p<0.005 ; *p<0.1

Source: Author

Third, Table 11 presents the results of the impact of the minimum bank capital requirement on loans granted to economic agents with financing needs. Four types of effects are observed. First, the minimum bank capital has a negative and significant effect on the amount of credit granted to the economy. Second, at the 1% threshold, the minimum bank capital has a positive and significant effect on the level of credit granted to public enterprises. Third, the minimum bank capital has a negative and significant effect on the level of bank credit to private enterprises. Fourth, the minimum capital requirement has a negative and significant effect on the level of credit granted to non-resident economic agents. Thus, a 1% decrease in the level of minimum bank capital reduces the level of credit granted to non-resident agents in the CEMAC.

These results suggest that bank capital requirements affect the financing of the economy. In some respects, minimum bank capital has a positive effect (TEG, CMT, CCT and CLT). For others, the minimum bank capital has a negative effect on the various economic agents that need financing (with the exception of loans granted to the economy). Some empirical studies have also come to this conclusion. An increase in minimum bank capital has a negative effect on the supply of credit to economic agents in need of financing. These results contradict those of Francis and Osborne (2009). For these authors, bank capital requirements are positively associated with the supply of credit. Bank capital has an upward effect on the amount of credit granted to loss-making agents. However, this increase depends on the level of minimum bank capital.

On the other hand, our results partially confirm the results found by Brun, Fraisse and Thesmar (2013), since according to these authors, a one per cent (1%) decrease in minimum bank capital reduces the distribution of credit by 10%, especially for economic agents in deficit. However, this result is different from the level of the term structure of credit. On the other hand, minimum bank capital tends to affect the level of the real cost of credit borne by the borrower. In other words, if a bank has sufficient capital, it tends to reduce the cost of credit.

Table 10: Impact of minimum bank capital requirements on the maturity structure of loans

	variable	Coefficient	S.D	Z	p > |z|	[(95% confidence interval)]	
CBM	CBM L1	0.231	0.017	13.36	0.000***	0.197	0.265
	CLT L1	0.401	0.003	10.63	0.000***	0.032	0.047
	CMT L1	-0.001	0.000	-2.41	0.016**	-0.002	-0.000
	CCT L1	-0.022	0.001	-12.34	0.000***	-0.026	-0.019
CLT	CBM L1	2.556	0.378	6.75	0.000***	1.814	3.298
	CLT L1	3.892	0.078	49.56	0.000***	3.739	4.046
	CMT L1	-0.423	0.126	-33.39	0.000***	-0.448	-0.398
	CCT L1	0.337	0.0183	18.37	0.000***	0.301	0.373
CMT	CBM L1	42.845	4.659	9.19	0.000***	33.711	51.978
	CLT L1	40.076	0.835	47.96	0.000***	38.439	41.714
	CMT L1	-4.370	0.138	-31.62	0.000***	-4.641	-4.099
	CCT L1	3.813	0.203	18.77	0.000***	3.414	4.211
CCT	CBM L1	-5.555	0.416	-13.35	0.000***	-6.371	-4.740
	CLT L1	2.622	0.100	25.97	0.000***	2.424	2.820
	CMT L1	-0.417	0.013	-31.55	0.000***	-0.443	-0.391
	CCT L1	0.099	0.022	4.51	0.000***	0.056	0.143

*** p<0.001 ; **p<0.005 ; *p<0.1

Source: Author

Table 11: Estimated impact of minimum bank capital requirements on economic agents with financing needs

	Variable	Coefficient	S.D	Z	p > |z|	[(95% confidence interval)]	
CBM	CBM L1	0.030	0.055	0.55	0.585	-0.078	0.139
	CE L1	-0.148	0.007	-21.19	0.000***	-0.162	-0.134
	CEPU L1	0.100	0.040	2.50	0.012**	0.021	0.179
	CSP L1	-0.005	0.002	-2.60	0.009***	-0.009	-0.001
	CNR L1	-0.115	0.178	-6.48	0.000***	-0.150	0.080
CE	CBM L1	2.717	0.073	36.75	0.000***	2.572	2.862
	CE L1	0.281	0.035	7.87	0.000***	0.211	0.351
	CEPU L1	-1.521	0.079	-19.16	0.000***	-1.677	-1.366
	CSP L1	0.044	0.002	-18.97	0.000***	-0.0488	-0.039
	CNR L1	0.535	0.030	17.48	0.000***	0.475	0.595
CEPU	CBM L1	-3.512	0.168	-20.88	0.000***	-3.841	-3.182
	CE L1	0.033	0.020	1.60	0.110	-0.007	0.073
	CEPU L1	1.336	0.079	16.83	0.000***	1.181	1.492
	CSP L1	-0.023	0.002	-10.22	0.000***	-0.028	-0.019
	CNR L1	-0.968	0.032	-30.07	0.000***	-1.031	-0.905
CSP	CBM L1	-24.670	0.780	-31.61	0.000***	-26.200	-23.141
	CE L1	1.417	0.146	9.70	0.000***	1.131	1.704
	CEPU L1	12.335	0.438	28.13	0.000***	11.476	13.195
	CSP L1	-0.263	0.022	-11.52	0.000***	-0.308	-0.218
	CNR L1	-4.672	0.204	-22.85	0.000***	-5.072	-4.271

CNR	CBM L1	-4.580	0.161	-28.35	0.000***	-4.897	-4.263
	CE L1	-0.121	0.016	-7.31	0.000***	-0.154	-0.089
	CEPU L1	1.092	0.060	18.06	0.000***	0.973	1.211
	CSP L1	-0.040	0.004	-8.71	0.000***	-0.049	-0.031
	CNR L1	-1.037	0.038	-27.23	0.000***	-1.112	-0.962

*** p<0.001 ; **p<0.005 ; *p<0.1

Source: Author

3.2. Robustness checks

3.2.1. Analysis of the causality of the variables

Note that in this study we use the Granger causality test for PVAR. Causality in the Granger sense for first-order PVAR is inferred from the estimation results above. Abrigo and Love (2015) call for the Granger causality test to be conducted with respect to the direction of causality between variables for a panel VAR. Table 12 below shows one of the results of the causality test between minimum bank capital and TEG.

Table 12: Granger causality test

Equation		Chi2	Df.	prob > Chi2
CBM	TEG	15.003	1	0.000
	ALL	15.003	1	0.000
TEG	CBM	11.193	1	0.001
	ALL	11.193	1	0.001

H0: no Granger causality exists for the excluded variable; Ha: Granger causality exists for the excluded variable.

Source: Author

Table 12 shows the results of the Granger causality test in the PVAR. The null hypothesis is that there is no cointegrating relationship. The test probabilities are below 5%. Therefore, the null hypothesis is rejected. There is causality between the minimum bank capital and TEG variables. Moreover, there is a bidirectional causality between the two variables. In other words, in the Granger sense, the minimum bank capital series causes the TEG series, because knowledge of the past of the minimum bank capital series leads to a prediction of the TEG series and vice versa.

Moreover, the causality tests of the models assessing the impact of the minimum bank capital requirement on the term structure of loans and on economic agents with financing needs (Appendix, Tables 1 and 2) lead us to accept the hypothesis of the existence of a co-integration relationship between the different series, since, according to these tables, all the test probabilities are less than 5%. Furthermore, as in the previous table, a bidirectional causality of the series is also verified.

3.2.2. Model stability test

Figures 1, 2 and 3 above are the results of the stability test on the equations of the panel VAR model. The results of these figures are presented in Tables 3, 4 and 5 (see Appendix). These tables show the results of the stability condition for the different models. These tables show the stability condition of the eigenvalues of the models. Two interpretations can be made at this level. The equations of the models evaluating the impact of the minimum bank capital on the TEG and the equations of the model evaluating the impact of the bank capital on the term structure of loans respect the stability condition of the eigenvalues because all the points are inside the unit circle. In other words, all the equations are stable.

Figure 1: Stability test for minimum bank capital and TEG

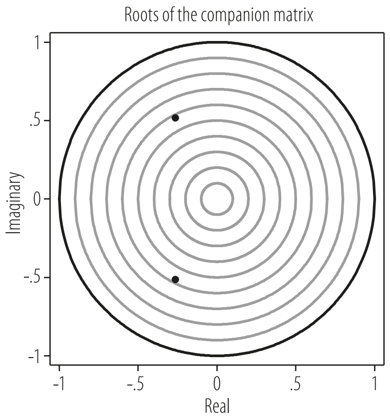
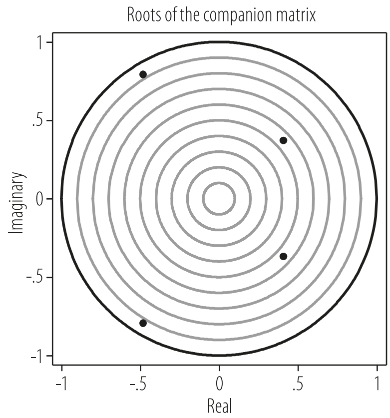
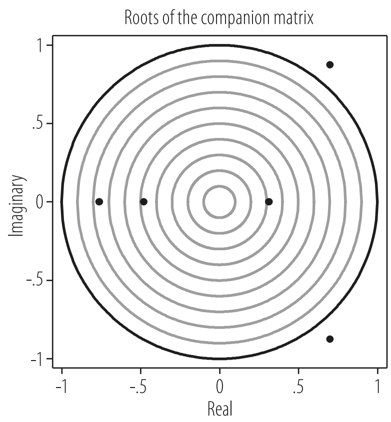


Figure 2: Stability test for minimum bank capital and term structure of lending



Source: Author

Figure 3: Stability test for Minimum bank and economic agents with financing needs



Source: Author

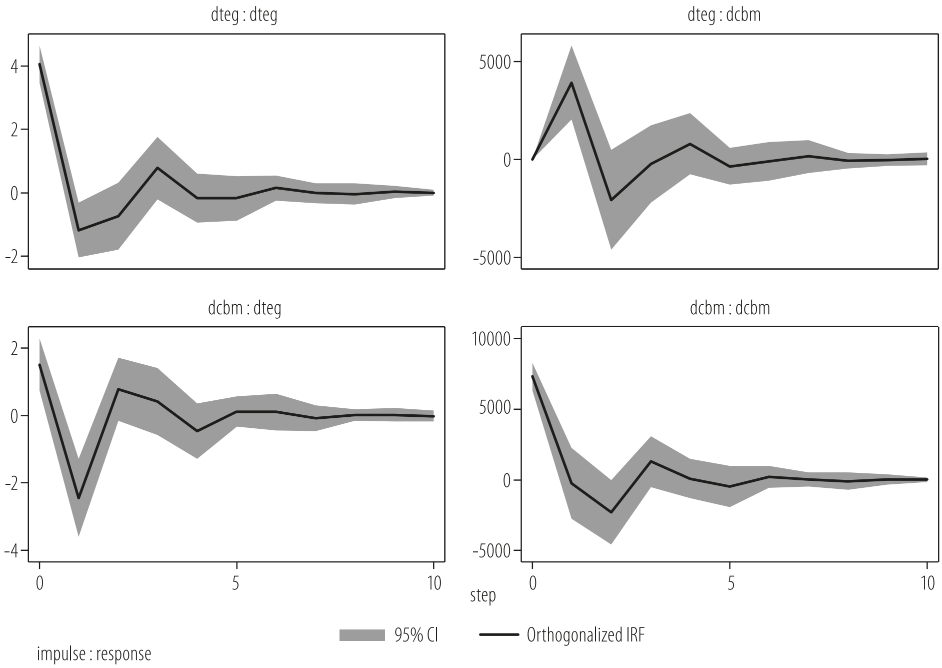
On the other hand, the model assessing the impact of minimum bank capital requirements on economic agents with financing needs shows two equations outside the unit circle. In other words, the model as a whole does not satisfy the stability conditions. However, three of these equations are stable. The points inside the unit circle satisfy the stability conditions. However, the points outside the circle are unstable.

3.2.3. Analysis of impulse response functions based on Monte Carlo simulations

In addition, impulse response analysis can be used to show the impact of one variable on another. In this study, we show the impact of minimum bank capital on eight other series of variables (TEG, CCT, CMT, CLT, CE, CEPU, CSP and CNR). The response functions were analysed using Monte Carlo simulations with 1,000 iterations.

Figure 4 shows the effect of the minimum bank capital shock on the TEG. The figure shows a positive shock at the beginning of the period. This is followed by a negative shock in the next two periods. However, from the fifth period onwards, the positive effect of the minimum bank capital on the TEG stabilises, albeit at a low level. At the end of the period, the effect disappears. The minimum bank capital reduces the real cost of credit borne by the borrower (total effective rate). The higher the minimum bank capital, the lower the real cost of credit. Economic agents with financing needs can therefore obtain the necessary funds at low cost.

Figure 4: Impact of bank capital requirements on the real cost of credit (TEG)

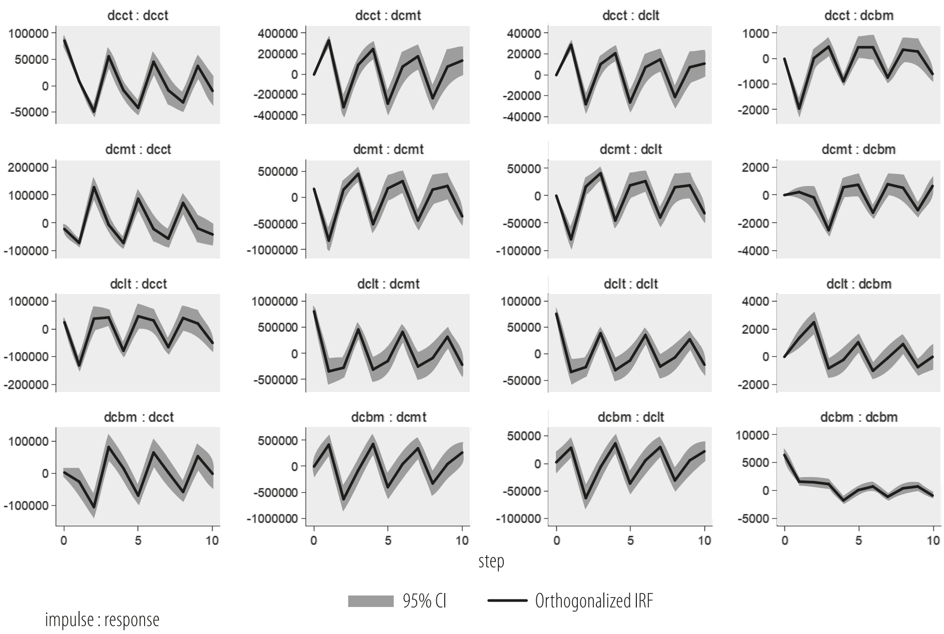


Source: Author

Figure 5 shows the impact of the minimum bank capital requirements on the maturity structure of loans (short, medium and long-term loans). This can be interpreted in three ways.

First, the minimum bank capital shock on the level of short-term loans shows a downward and then an upward fluctuation. In other words, the curve changes direction almost every two periods. It is either positive or negative. But in the long run, it becomes negative. In other words, the low level of minimum bank capital tends to reduce the level of short-term credit granted to loss-making economic agents. Then, with regard to the shock of the minimum bank capital on medium-term loans, we first observe a positive effect. This is followed by a negative shock in the second period. Finally, there is a positive shock to the level of short-term loans. In the long run, an increase in the level of minimum bank capital makes it possible to increase the level of medium-term loans over a long period of time. Finally, with respect to the shock to the level of bank capital on long-term loans, we see the same type of effect as in the previous case. Positive and negative shocks alternate. In the long run, the desired effect is positive for long-term loans compared to short-term loans.

Figure 5: Impact of bank capital requirements on the maturity structure of loans

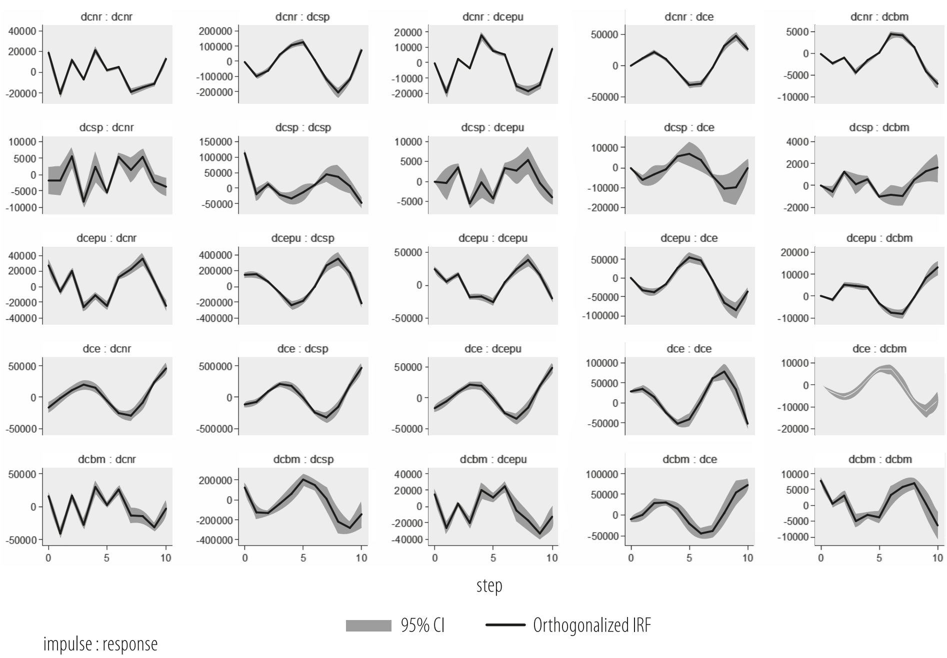


Source: Author

Finally, Figure 6 allows us to analyse the shock of minimum bank capital on loans granted to different economic agents with financing needs. In this case, we analyse four main shocks. First, there is an almost negative shock from the minimum bank capital requirement on the level of loans granted to non-residents. However, the trend seems to be positive from the fourth to the seventh period. The trend then declines. But in the long run, the desired effect becomes positive. Second, the impact of the minimum bank capital requirement on lending to the private sector can be divided into two main phases. There are two downward trends (negative shocks) and two upward trends (positive shocks). However, these trends can also be explained by the level of bank capital requirements. A low level of minimum bank capital has a negative effect on the level of lending, while a high level of minimum bank capital increases the level of lending, other things being equal.

In the long run, there is a positive effect between minimum bank capital and credit to the private sector. Third, the effect of the minimum bank capital shock on the level of credit to public enterprises is also unstable. During the first four periods, the behaviour of the level of credit to public enterprises is erratic. Then there is a positive shock. Finally, the downward trend continues. In the long run, however, the impact tends to be positive. Fourth, we analyse the impact of minimum bank capital on the level of credit granted to the economy. There are three phases. There is a positive effect, followed by a short-term decline in the curve. Finally, the effect increases (positive shock) at the end of the period.

Figure 6: CBM shock on loans to borrowers



Source: Author

In summary, the analysis of the above results leads to two main conclusions. The first is that there is persistent instability in the effects of bank capital requirements on the various variables. This instability is due to the different levels of minimum bank capital among credit institutions in the CEMAC countries. Second, the level of minimum bank capital positively affects the level of the term structure of long-term loans, with the exception of short-term loans. Moreover, in the long run, minimum bank capital has a positive impact on loans granted to various economic agents in need of financing. It should also be noted that minimum bank capital tends to reduce the real cost of credit borne by the borrower.

It can therefore be said that minimum bank capital has a positive long-term effect on the financing of the economy by making bank credit available and less costly. Thus, an increase in bank capital requirements ipso facto leads to a decrease in the real cost of credit. The interpretation of the impulse response functions shows us that the minimum bank capital has a positive and significant effect on the financing of the economy. These results allow us to verify our research hypothesis.

4. Conclusion and policy recommendations

The aim of this paper was to show the effect of the level of minimum bank capital of credit institutions on their ability to finance the economy in the Central African Economic and Monetary Community. The analysis of theoretical and empirical works supports the idea that the minimum capital of credit institutions has a positive and significant effect on the financing needs of economies. The empirical analysis has allowed us to arrive at certain results. We have reached three types of conclusions. First, minimum bank capital has a positive effect on our variables, i.e. an increase in the level of minimum bank capital increases, other things being equal, the levels of credit discussed in this study. In addition, an increase in the level of minimum bank capital makes it possible to reduce the level of the real cost of credit borne by the borrower (total effective rate). Second, there is a positive and significant effect on the term structure of loans, although it is negative for the level of short-term loans. This result is interpreted as reflecting the low level of minimum bank capital in the CEMAC economies. Third, the analysis of the impulse response functions shows instability of the minimum bank capital shock on the different variables. This instability has been interpreted as reflecting the wide variation in the level of minimum bank capital among credit institutions in these economies. In the long run, however, the desired effect is positive.

Finally, it is necessary for the Banking Commission of the Central African States to increase the minimum level of bank capital and to encourage credit institutions in the CEMAC economies to increase the level of minimum bank capital. The COBAC should also ensure strict compliance with this rule, as it contributes to the internal stability of credit institutions (stability, liquidity and soundness) and external stability (provision of resources to economic agents in need of financing). An extra franc in minimum bank capital would therefore be an extra franc to keep the economy going. Nevertheless, one of the constraints of this study is that, for the findings to be more reliable, it would be beneficial to utilise the microeconomic data for individual banks in order to examine the influence of bank capital on the financing capacity of CEMAC banks, rather than on a global scale, but rather on an individual basis.

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Appendix

Table 1: Causality test between CBM and maturity structure of loans

Equation / Excluded		Chi2	df	prob > Chi2
CBM	CLT	112.943	1	0.000
	CMT	5.829	1	0.016
	CCT	152.308	1	0.000
	ALL	1205.075	3	0.000
CLT	CBM	45.565	1	0.000
	CMT	1114.919	1	0.000
	CCT	337.574	1	0.000
	ALL	6372.076	3	0.000
CMT	CBM	84.536	1	0.000
	CLT	2300.219	1	0.000
	CCT	352.440	1	0.000
	ALL	6522.894	3	0.000
CCT	CBM	178.305	1	0.000
	CLT	674.461	1	0.000
	CMT	995.677	1	0.000
	ALL	1459.499	3	0.000

H0: no Granger causality exists for the excluded variable; Ha: Granger causality exists for the excluded variable.

Source: Author

Table 2: Causality test between CBM and economic agents with financing needs

Equation / Excluded		Chi2	df	prob > Chi2
CBM	CE	10901.777	1	0.000
	CEPU	542.067	1	0.000
	CSP	268.960	1	0.000
	CNR	2135.643	1	0.000
	ALL	23213.059	4	0.000
CE	CBM	28010.990	1	0.000
	CEPU	14730.335	1	0.000
	CSP	1286.481	1	0.000
	CNR	5984.871	1	0.000
	ALL	43331.118	4	0.000
CEPU	CBM	6487.704	1	0.000
	CE	16.057	1	0.000
	CSP	627.387	1	0.000
	CNR	11402.119	1	0.000
	ALLL	11935.713	4	0.000
CSP	CBM	7502.311	1	0.000
	CE	2217.208	1	0.000
	CEPU	22934.215	1	0.000
	CNR	4745.366	1	0.000
	ALL	25224.302	4	0.000
CNR	CBM	8747.079	1	0.000
	CE	1324.432	1	0.000
	CEPU	3261.143	1	0.000
	CSP	2089.491	1	0.000
	ALL	11324.587	4	0.000

H0: no Granger causality exists for the excluded variable; Ha: Granger causality exists for the excluded variable.

Source: Author

Table 3: Stability test of the model assessing the impact of CBMs on TEG

Eigenvalues		Modulus
Real	Imaginary	
-0.261	-0.514	0.577
-0261	0.514	0.577

Pvar satisfies the stability condition of the model as all eigenvalues are inside the unit circle, i.e. less than 1.

Source: Author

Table 4: Stability test of model assessing impact of CBM on maturity structure of loans

Eigenvalues		Modulus
Real	Imaginary	
-0.481	-0.793	0.928
-0.481	0.793	0.928
0.408	-0.369	0.550
0.408	0.369	0.550

Pvar satisfies the stability condition of the model as all eigenvalues are inside the unit circle, i.e. less than 1.

Source: Author

Table 5: Stability test of the model assessing the impact of the CBM on economic agents with financing needs

Eigenvalues		Modulus
Real	Imaginary	
0.701	0.874	1.121
0.701	-0.874	1.121
-0.760	0	0.760
-0.477	0	0.477
0.314	0	0.314

Pvar satisfies the stability condition of the model as all eigenvalues are inside the unit circle, i.e. less than 1.

Source: Author

Table 6: Comparative minimum bank capital requirements for a number of African countries

Pays	Country Minimum bank capital in local currency	Minimum bank capital in USD Current rate 28/07/2020	Current rate 28/07/2020 Minimum bank capital in EUR Current rate 28/07/2020	Minimum bank capital in millions of CFA francs (XAF) Current rate 28/07/2020
South Africa	250 million Rands	18,975,000	16,275,644	10,676
Algeria	10 billion Algerian dinars	84,000,000	84,000,000	47,407
CEMAC	10 billion CFA francs	17,771,000	15,244,000	10,000
Ghana	Cedis 400 million	84,000,000	84,000,000	47,655
Nigeria	25 billion Naira	69,250,000	59,500,000	38,971
UEMOA	10 billion CFA francs	17,771,000	15,244,000	10,000
Tunisia	150 million Tunisian Dinars	84,000,000	72,000,000	31,601

Source: Author, based on data from central banks and banking commissions.

Table 7: Early use of coercive measures

Bank category	Capitalisation thresholds	Main restrictions
Well capitalised	$\text{RCAR} \geq 10\ \%\ \text{et RLF} \geq 5\ \%$	None
Adequately capitalised	$\text{RCAR} \geq 8\ \%\ \text{et RLF} \geq 4\ \%$	None
Undercapitalised	$\text{RCAR} \leq 8\ \%\ \text{et RLF} \leq 4\ \%$	Capital restoration plan Suspension of dividends, Restriction on asset growth, Prior authorisation of acquisition
Substantially undercapitalised	$\text{RCAR} \leq 6\ \%\ \text{et RLF} \leq 3\ \%$	Recapitalisation required, Restriction on transactions with subsidiaries, Restriction on lending rates, Increased restrictions on asset growth, Ban on correspondent deposits, Replacement of managers.
Critically undercapitalised	$\frac{\text{capital}}{\text{total asset}} \leq 2\ \%$	FDIC resolution placement: Restructuring assisted liquidation

Source: Author, based on: FDIC, FED, Mishkin (2010).