Banks and monetary policy transmission in West African Economic and Monetary Union

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Abstract

This paper aims at examining the role of banks in the transmission of the monetary policy in the West African Economic and Monetary Union (WAEMU). Using a simple theoretical model, it shows that improving the quality of institutions and an increase in competition strengthen the transmission of monetary policy while capital requirement behaves as an additional cost to the borrowers. Applying a dynamic panel estimator to a large sample of WAEMU banks, I find that bank lending is sensitive to monetary policy and capital-constrained banks reduce further their lending following a tight monetary policy compared to less capital-constrained banks. Moreover, an improvement in the quality of institutions seems to strengthen the transmission of monetary policy. These provide supports for the theoretical predictions.

*I wish to express my deep appreciation to African Economic Research Consortium (AERC) for the financial support to carry out this research. I am also grateful to the resource persons and members of AERC's thematic group C for various comments and suggestions that helped the evolution of this study from its inception to completion. I also thank my supervisors and participants at the two days research workshop for PhD students at Paris School of Economics, France, 3-4 December 2015. I am are indebted to the anonymous referees who reviewed the paper and provided comments and suggestions that helped in shaping and improving the overall quality of the paper. The findings made and opinions expressed in this paper are exclusively those of the author. The author is also solely responsible for content and any errors. Email: kouame-desire.kanga@etu.univ-orleans.fr.

1 Introduction

The current prudential framework of the WAEMU requires that banks equity capital must be at least equal to a statutory minimum capital. The minimum capital threshold was 1 billion CFAF from 2000 until 2008. In 2007, it was raised to 5 billion CFAF with effect from 2008 and raised further to 10 billion CFAF in 2015, with a grace period which allows banks to conform to this new standard by July 1st, 2017 at the latest. In the same vein as the current Basel III regulation on capital which proposes to increase banks' capital adequacy ratio, these successive increases in the minimum capital level aim at promoting a more stable and resilient banking sector to crises by containing risk-taking behaviour, which in turn, is expected to effectively contribute to the financing of WAEMU's economies. The concern is that while they may provide a buffer against expected risk, high capital requirements constrain the banks' capacity to lend. If banks decide to hold more capital (e.g., Barrios and Blanco, 2003) in order to comply with the regulation, the pass-through from policy rate to lending will be reduced. Thus, capital regulation can reduce the transmission of monetary policy.

The behaviour of the banks could be strengthened by the risk level of the bank, the quality of institutions and the competition in the banking sector. According to Altunbas, Gambacorta, and Marques-Ibanez (2010), banks with a low level of risk are able to supply a larger amount of money in period of monetary policy restriction. In fact, low exposure to risk increases the probability of refinancing on the market, which helps to maintain or even increase the supply of credit. Banks may thus get free from constraints induced by the changing in the monetary policy and meet the demand for credit. However, such risk taking behaviour of the banks is obviously not possible in a developing countries with poorly developed or inexistent equity markets. Banks, as a company, are supposed to reduce their level of intermediated credit with the level of risk in the economy. The level of risk grows with the political and economic uncertainty. That is why business environment, institutional quality and political risk will affect the transmission of monetary policy via banks as they do for other micro and macroeconomic indicators (eg. Gohou and Soumaré, 2012). It will operate via an increase of cost of credit. As mentioned by Mishra et al. (2014), the more unfavourable is the domestic institutional environment for financial intermediation, the more rapidly intermediation costs increase. In addition, Mishra and Montiel (2013) show that when the institutional environment is weak and the banking system non-competitive, banks have less incentive to adjust the cost of credit as a result of the decreasing of the interest rate. Moreover, the absence of any interbank market weakens the transmission of the monetary policy in Africa (Laurens, 2005). Thus, the environment in which banks operate influences their behaviour with regard to the transmission of the monetary policy. Previous works conducted in the WAEMU region suggested that the policy rates appear to affect the money market rate, interbank rate and average lending rate but financial development and banking sector concentration strongly affects the impact of monetary policy.

This paper takes the view that the banking system is one key factor of the transmission of monetary policy. It seeks to examine the role of banks in the transmission of the monetary policy in the West African Economic and Monetary Union (WAEMU) with a focus on capital regulation and institutions. The main question may be formulated as follows: to what extent

the availability of bank credit depends on the monetary policy and does it depend on banks' characteristics? This approach is supported by the bank-centric theory. According to that theory, the special response of banks to changes in monetary policy is their lending response. Monetary interventions do something special to banks and through banks, firms and consumers are also affected. Therefore, the role of banking sector is central to the transmission of monetary policy. Two key factors shape the way in which monetary policy works (Kashyap and Stein, 1997): (1) the extent to which banks rely on reservable deposit financing and adjust their loan supply schedules following changes in bank reserves; (2) the extent to which some borrowers are bank-dependent and cannot easily offset these shifts in bank loan supply. For these reasons, the analysis of the dynamics of credit activity in relation to changes in monetary policy should take into account banks' characteristics as well as the business cycle and the quality of institutions.

This paper focuses on lending response of banks in WAEMU region. The contribution of the paper is to measure the efficiency of the monetary policy, not from a macroeconomic perspective, but at micro level using hand collected bank balance-sheet data unlike the common empirical investigations (eg. Beguy, 2012; Davoodi, Dixit, and Pinter, 2013; Laurens, 2005; Lungu, 2007; Mishra and Montiel, 2013; Mishra, Montiel, and Spilimbergo, 2012; Nubukpo, 2007; Sacerdoti, 2005). Similar studies have been conducted in European Zone (eg. Angeloni, Kashyap, and Mojon, 2003; Ehrmann et al., 2003b; Gambacorta, 2005) and in United States (eg. Kashyap and Stein, 1995, 2000; Kashyap, Stein, and Wilcox, 1993, 1996). They all lead to two important conclusions. First, the monetary policy influences the credit supply of banks. The effects of the monetary policy are amplified by some specific characteristics of banks such as capital, size, liquidity and risk taking. On the other hand, the structure of the financial system in the different countries may explain the existence of heterogeneity in the transmission of the monetary policy.

The first part of this paper is theoretical. It contributes to put forward a plausible explanation of lending behaviour of the WAEMU banking sector by taking account the regulatory framework and quality of institutions. I develop a simple partial equilibrium model closely related to the works of Gerali et al. (2010) and Mishra et al. (2014). I show that loan demand depends negatively on the policy rate as highlight in the literature. Second, improving the quality of institutions and an increase in competition strengthen the transmission of monetary policy. Third, as far as the regulator increases the capital requirement ratio, banks become capital constraint and therefore decrease lending much further in response to monetary tightening.

The second part of this paper is empirical. It aims at testing specific predictions of the theory utilizing hand collected panel data for about one hundred banks over a fifteen-year period. I uncover four important findings. First, I find that bank lending is sensitive to monetary policy. Second, I uncover that a capital-constrained bank reduces further its lending following a tight monetary policy as compared to a less capital-constrained bank. Capital regulation behaves as additional costs and results in a decline in credit. Third, poor institutions weaken the transmission of monetary policy while an improvement in the quality of institutions seems to strengthen it. In poor environment, banks lend to large enterprises and governments (Haselmann and Wachtel, 2010) which greatly reduce the cost of information gathering. In this context, they are less sensitive to monetary policy. Fourth, monetary policy is less effective for banks with high market power. Therefore, high market power leads to an increase in bank lending maybe

because of the size of the banking industry of the region.

In what follows, section 2 presents the monetary policy in WAEMU region and the transmission channels. Section 3 presents an overview of the structure of the banking sector of the WAEMU, the theoretical model and the research hypotheses. Section 4 presents the empirical strategy, data and descriptive statistics. Section 5 discusses the empirical results. Section 6 presents the additional robustness checks of the findings and I conclude in Section 7.

2 Monetary policy in WAEMU region and transmission channels

WAEMU is a currency union composed of eight countries: Benin, Burkina Faso, Cote d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal and Togo. These countries share the same currency, CFA Franc, which is pegged to the Euro. The monetary policy is conducted by the Central Bank of West Africa States (BCEAO) which is empowered to take any measures concerning instruments and rules related to the credit policy applicable to credit institutions including compulsory reserves and the rates and conditions of the operations made by credit institutions with their clients.

Under a fixed exchange rate regime, capital controls may give some monetary autonomy to a central bank (Farhi and Werning, 2014; Klein and Shambaugh, 2015; Rey, 2016). In the WAEMU region, there is capital controls on all outward capital transfers, except for the amortization of debts and repayment of short-term loans, while inward capital transfers are liberal. Capital mobility is therefore restricted and can lead to monetary policy independence based on theoretical considerations.

The literature suggests three approaches to check the empirical evidence of monetary autonomy under fixed echange rate regime including the inflation differential between the two regions and the sensitivity of the local interest rate to the foreign rate. Figure 1 shows the evolution of regional inflations in WAEMU and euro area. Inflation in the WAEMU is much volatile and higher than inflation in euro area. The WAEMU-euro inflation deviation lies between -2.71 and +5.88 percent points. The large differences of inflation occur between April and December 2008 and are mainly due to the surge in oil prices. These deviations may justify an interest rate differential between the two regions because of exogenous (e.g. oil) shocks that may affect the WAEMU economies, even though inflation in WAEMU is highly sensitive to WEAMU-specific shocks (Kireyev, 2015).

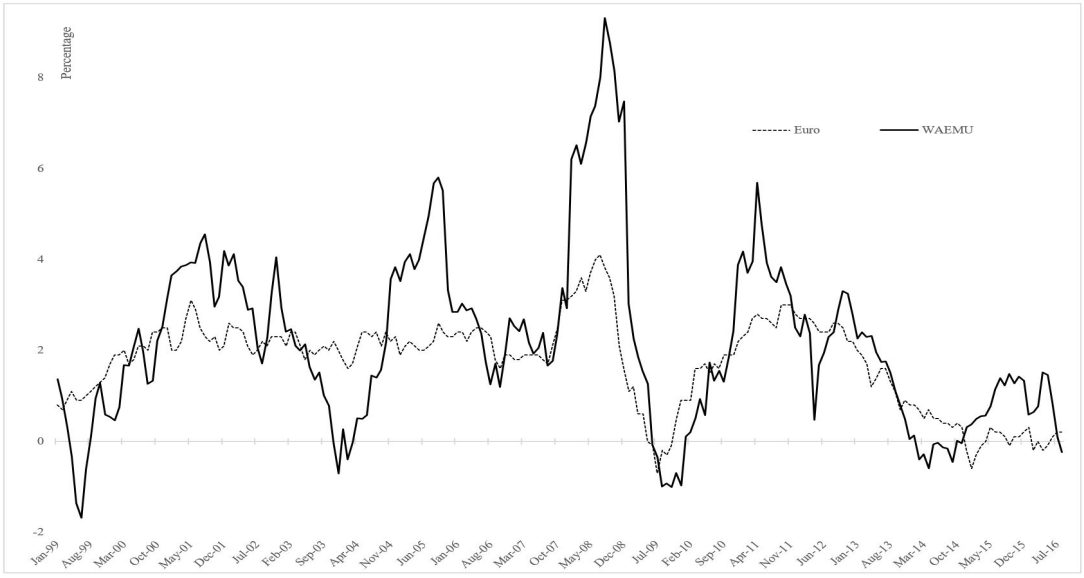
Furthermore, Kireyev (2015) conducts econometric tests and found no cointegration between ECB and BCEAO rates; that is BCEAO is able to set its own nominal interest rate (Frankel, Schmukler, and Serven, 2004).

In sum, the BCEAO has the ability to conduct its own monetary policy. First, WAEMU controls the international capital flows. Second, there are deviations between WAEMU-euro inflation rates. Third, the ability to set nominal interest rates in the WAMEU region is not sensitive to the changes in the euro area rates. This makes a case for studying the monetary transmission mechanisms in the WAEMU.

In order to conduct monetary policy, the BCEAO uses two main instruments: interest rates and reserve requirements. The central bank sets two interest rates: the minimum bid rate

Figure 1: Evolution of inflation in WAEMU and Euro area

These graphs show the evolution of inflation on WAEMU region and Euro area. Inflation is computed as annual percentage changes of HICP. Monthly data come from BCEAO and ECB over the period Jan.-1999-Aug.-2016.



(main policy rate) and the maximum lending rate. Since the restructuring of the banking sector in 2004-2005, the central bank has increased usage of market mechanisms by establishing open market operations allowing liquidity injection in the banking sector. The liquidity injection helps to steering the interest rate and has been helpful to deal with a structural liquidity shortage of small and fragile banks that have limited access to funding in narrow and segmented interbank market. Finally, the BCEAO sets reserve requirements ratios. Prior to December 16$^{\text{th}}$, 2010, the reserve requirements ratios varied from country to country to address country-specific problems. These ratios have been unified and set to 7% on December 16$^{\text{th}}$, 2010 and then to 5% since March 15$^{\text{th}}$, 2012.

Monetary policy conducted by the BCEAO is expected, in the short and medium term, to affect inflation, output and employment through five channels namely exchange rate, credit, asset prices, expectations and interest rate. Due to the features of the financial structure of member states of the WAEMU, all these channels cannot properly work. The exchange rate channel is not applicable under fixed exchange rate regime. The other four channels can only be operational if the money market, the interbank market, the debt and the equity markets are fully working. Unfortunately, as documented by Kireyev (2015), these markets are struggling to play their full role. First, the money market is almost restricted to liquidity injections of the BCEAO. As a consequence, the average rate on this market is not representative of the market conditions in the regional banking system and gives very few options to the expectations channel to be fully functional because this channel relies on the public's perception of monetary policy signal. Second, the interbank market is narrow and segmented with borrowing (or lending) less than 2% of the total banks' lending. The debt market is limited to the government bonds, T-bills and debt securities of private companies with a market capitalization under 2% of regional GDP in 2014. Therefore, the central bank cannot fully influence the governments' borrowing costs because of the absence of a secondary debt market. Third, the stock market is very shallow with

less than 40 listed companies, whose capitalization is barely 10% of GDP. Accordingly the asset price channel cannot work: the central bank has a very limited influence on short-term T-bill rates and this impact does not translate into the long-term rates on government bonds.

As a result, only credit channel seems relatively active. This channel allows the central bank to affect the volume of banks' lending. Cuts in the policy rate, liquidity injection and reducing in reserve requirements increase bank's free liquidity. With this additional liquidity, banks can increase their volume of loans and decrease the lending rate. This can attract borrowers, increases loan demand and allow borrowers to increase their consumption or investment. This paper is limited to the effect of policy rate on bank lending.

Even if the credit channel seems to be dominant, however, the efficiency and reliability of the monetary transmission depend on the characteristics of the banks and the quality of institutions of the country. First, banks are the main source of the private sector financing because the financial markets are underdeveloped in African countries. Thus, a decline of the interest rate should boost credit activity while a restrictive monetary policy may reduce it. However, in the presence of a highly concentrated banking system, as it is the case in the developing countries, a decrease in the policy rate is reflected in the margin of the bank rather than in the volume of credit (eg. Kourelis and Cottarelli, 1994).

Second, taking into account the banking sector characteristics in the analysis of the transmission of the effects of the monetary policy allows us to distinguish the supply and demand effects. In fact, a change in credit resulting from a restrictive monetary policy may be due to the credit demand or supply. Banks may decide to reduce their credit supply in response to a restrictive policy for instance by increasing the lending rate because of liquidity or capital constraints (eg. Gambacorta, 2005; Hosono, 2006; Levieuge, 2005). However, firms can change their financing options bypassing the banking sector so that the credit may increase after a restrictive policy. In the case of developing countries, it would result in increasing in the credit requested from the informal sector (eg. Aryeetey, 2002).

Third, if the quality of institutions leads to an increase in the cost of credit, banks can reduce the credit supply so as to weaken the transmission of monetary policy (Mishra et al., 2014; Ndikumana, 2014). Indeed, the weak institutions (Sacerdoti, 2005) combine with past crisis and low demand (Beguy, 2012) rise the demand for excess reserve. As a result, banks have less incentive to adjust the cost of credit (Mishra and Montiel, 2013) and increase lending. This effect is much more important when the banking sector is non-competitive.

Fourth, the regulatory framework influences the capital of bank and therefore their credit supply. The effect of the monetary policy is stronger for under-capitalised, small and less liquid banks (eg. Kashyap and Stein, 2000; Kishan and Opiela, 2000). Under-capitalized banks are less able to collect deposits so as to either maintain or increase their credit supply during monetary restriction. Indeed, banks are subject to interest-rate risk (Gambacorta and Mistrulli, 2004) and so, if they do not have sufficient capital and if raising additional funds is costly, they reduce the loans for fear of not meeting the regulatory capital ratio. The mechanism of bank capital relies on a gap between the maturity of assets and liabilities of the bank and not only the bank capital. However, even if the capital of a bank is more than the required capital, a bank could limit its loan portfolio extension to reduce the risk of capital deficiency in the future (Van den

Heuvel, 2006). Therefore, the regulatory framework plays a role via banks' balance-sheets.

3 Theoretical background

The banking sector is small compared to developed countries such as Euro area or US. The ratio of banks total assets to GDP was 53.83% (85% in Togo and 33% in Niger) in 2013, the highest one since 1960. The small size of the banking system shows that the banking loans might be limited. The bank lending remains less than 40% of the GDP in the region. The structure of bank financing is more oriented towards short-term credit (less than one year). But there is a slight shift in this structure from 1990 to 2013. Over the period 2010-2013, the share of short-term credit is 55% while the share of the medium-term (1-5 years) credit increases from 22% (1990-1999) to 35% (2010-2013). In almost all the countries, the long-term credit is very scare with the exception of the period 1990-1999.

3.1 Banking sector and its implications for monetary policy transmission

One implication of the importance of short-term loans in the region is that risk taking channel is not working in the sense that banks take risk from firms, by granting loans, and repackage these risks and sell them to other banks or financial institutions, very often by securitization. Second, it may limit economic growth (Ndikumana, 2014) because financial development literature suggests that an increase in bank credit can lead to higher economic growth (eg. Allen and Giovannetti, 2011; Esso, 2010). Third, it can accelerate the transmission of monetary policy impulses to lending rates and thus borrowing costs (Ehrmann et al., 2003a).

The structure of bank lending might explain why the interbank market is under-developed with few participation especially because of their high liquidity position. In fact, the ratio of total loans to deposits (LTD) is close to one since 1995. This ratio shows that the banking sector relies on its own deposits to make loans to its customers, without any outside borrowing. The ratio of LTD may be explained by the memory effect relative to the crisis of 80s (Beguy, 2012).

A second distinguish characteristics of the WAEMU region is the small number of firms which have access to the bank credit mainly due to the collateral constraints. The proportion of firms which have access to credit ranges from 2.75% (in Guinea-Bissau) to 45.56% (in Benin) and except for Cote d'Ivoire and Mali, at least 80% of bank loan are collateralized. Access to financing is still a major constraint for more than the half of the firms. First, in all countries, at least 80% of the firms need a loan but they are not able to deal with the collateral constraint. Next, the corporate sector does not rely on debt securities according to the size of the stock market capitalisation ($\approx$ 30% of the GDP). On the one hand, these data suggest that the volume of credit is determined by the supply side of the credit market: banks determine the volume and allocation of credit. On the other hand, the high percentage of loans backed by collateral means that the response of bank loans to monetary policy can be furthermore accentuated through the "balance sheet channel"[1].

[1] See, among others, Bernanke and Gertler (1989); Bernanke, Gertler, and Gilchrist (1999); Kashyap and Stein (1997).

The banking sector is also highly concentrated. In average, the concentration index, proxies by the share of the three largest banks in terms of assets, ranges from 69% in Burkina Faso to 99% in Togo. As the banking sector is concentrated and small, it could lead to great profitability due to the monopolistic power of bankers according to the *structure-conduct-performance* approach (e.g., Berger et al., 2004) even though these authors outline that the degree of competition does not influence bank's profitability and interest rate. Another strand of the literature argues that the market contestability and regulatory restrictions are sources of market power (e.g., Demirguc-Kunt, Laeven, and Levine, 2004)

From the regulatory point of view, the banking sector of the region is well-capitalized. The prudential framework[2] is strongly inspired by Basel I with a capital ratio of 8%. Banks equity capital must also be at least equal to the regulatory minimum capital. This minimum threshold was fixed to 1bn CFA Francs until 2008. It was raised to 5bn CFAF during a first phase and to 10bn CFAF during a second phase[3]. From 2000-2014, the average risk coverage ratio was 8.3% (see table 4). In 2014, 81.25% of the banks comply with the minimum capital. Because of their level of capital, one expects that banks be less sensitive to monetary policy even though capital constraints will accelerate the monetary transmission.

3.2 Model

In short, the banking sector is small, well-capitalised and highly liquid. It is also highly concentrated while slightly competitive. A wide range of reasons can justify the behaviour of banks. First, the quality of institutions may play a role (Mishra and Montiel, 2013; Sacerdoti, 2005). The Regulatory Quality Index is always negative (between -.996 and -.089 from 1996 to 2013) showing that the governments are less able to formulate and implement sound policies and regulations that permit and promote private sector development. Second, the lack of creditworthy borrowers limits the ability of banks to lend because only a limited number of firms are able to fulfil the collateral requirements. Third, loan defaults is one major factor inhibiting bank lending (Andrianova et al., 2015). Fourth, the regulatory framework may limit the bank lending especially when the institutional environment is weak like in the WAEMU region.

In this section, a simple model of bank lending behaviour highlights some key determinants of monetary transmission in a context of low quality of institutions, high concentration and capital-requirements.

3.2.1 Basic equations of the model

Consider a representative commercial bank that manages a portfolio composed of loans (L_t) to private sector. It finances the portfolio by issuing deposits (D_t). Therefore, the bank's balance sheet is given by $L_t = D_t + K_t$, where K_t is bank's capital. I assume that the bank is a monopolistic competitor in the market for loans and deposits. The implication is that banks adjust rates on loans (r_t^l) and deposits (r_t^d) to maximise their profit. Banks also accumulate

[2]See `http://www.bceao.int/IMG/pdf/dispositif_prudentiel_revu_vf-pdf.pdf`.

[3]The second phase was launched following the meeting of the Council of Ministers of the WAEMU on March 30th 2015. This increase in the minimum capital is in the perspective of promoting a healthy and strong banking and financial system which will be more likely to effectively contribute to the financing of economic development of the WAEMU member states.

capital through retained earnings. Based on the regulatory framework, I assume that banks have an optimal target for their capital-to-assets ratio (θ) and deviation from which imply a quadratic cost as in Gerali et al. (2010). This setup is a shortcut for studying the implications and costs of regulatory capital requirements. The cost is parameterized by a coefficient κ and is proportional to outstanding bank capital.

The problem of the bank may be summarized as follows

$$\max_{L_t, D_t} r_t^l L_t - r_t^d D_t - \frac{\kappa}{2}(\frac{K_t}{L_t} - \theta)^2 K_t - (\gamma_0 L_t + \frac{\gamma_1}{2}(L_t - \underline{L})^2) \tag{1}$$

γ_0 and γ_1 are positive parameters of the costs of intermediation and $\underline{L}$ is the volume of loans that the bank can extend to firms that offer good collateral. Due to imperfections in the credit market, the bank faces costs to extend credit to a company. The cost of credit increases linearly (with a slope γ_0) with the volume of credit up to a threshold $\underline{L}$. Beyond this volume, the bank faces quadratic costs that depend on the institutional environment (γ_1). γ_1 decreases with the quality of the institution. As in Mishra et al. (2014), "more unfavourable is the domestic institutional environment for financial intermediation, the smaller the pool of bank customers with low lending costs, and the more rapidly intermediation costs increase with the loans extended beyond it favoured customers".

To close the model, I assume that the demand for loans depends negatively on loan rate (r_t^l) and on a set of variables $\underline{Y}$ which describe the global macroeconomic conditions (GDP, prices, etc.) as follows

$$L_t = L_0(\underline{Y}) \exp(-\omega r_t^l) \tag{2}$$

where ω is the semi-elasticity of loan demand. It measures the inverse of banks' market power in the model, that is an increase in ω leads to low market power. Similarly, the supply of deposits is positively related to the deposits rate which is assumed to be equal to the policy rate, r_t.

3.2.2 Analysis of the bank behaviour

Solving the equation (1) using banks' balance sheet constraints leads to:

$$r_t^l = \gamma_0 + r_t - \kappa \left(\frac{K_t}{L_t} - \theta\right) \left(\frac{K_t}{L_t}\right)^2 + \gamma_1 (L_t - \underline{L}) \tag{3}$$

Replace (3) into (2) yields to

$$\log L_t = \omega_0 - \omega \left(r_t - \kappa \left(\frac{K_t}{L_t} - \theta\right) \left(\frac{K_t}{L_t}\right)^2 + \gamma_1 L_t \right) \tag{4}$$

where $\omega_0 = \log L_0(\underline{Y}) - \omega(\gamma_0 - \gamma_1 \underline{L})$

The analysis of this paper is based on equation (4) which shows the relationship between loan demand, policy rate, bank capital, capital requirements and quality of institutions. To highlight the implications of this equation for analysis, I take its log-linear version to get the

following relationship

$$\hat{l}_t = \frac{\omega}{1+\omega\left[\gamma_1 L + \kappa\left(\frac{K}{L}\right)^2\left(3\frac{K}{L}-2\theta\right)\right]}\left(-r\hat{r}_t + \kappa\left(3\frac{K}{L}-2\theta\right)\left(\frac{K}{L}\right)^2\hat{k}_t\right) \tag{5}$$

where the notation $\hat{x}_t$ is the log deviation of the variable, x_t, from its steady state, x.

By assuming that $0 < \theta < 1$, it follows that $1+\omega\left[\gamma_1 L + \kappa\left(\frac{K}{L}\right)^2\left(3\frac{K}{L}-2\theta\right)\right] > 0$. Therefore, the following conclusions may be drawn from the model.

First, the effect of bank capital on loan demand depends on the regulatory framework, θ. Higher values of bank capital lead to higher loan demand if $\theta < 3K/2L \equiv \theta^\star$, otherwise loan demand will be under its long-run level. Second, loan demand depends negatively on the policy rate as highlight in the literature. Third, sensitivity of loan demand to interest rate and to banks' capital depends on κ (adjustment cost parameter), θ, γ_1 (quality of institutions) and ω (market power). An increase in θ, with capital adjustment cost, leads to an increase in the sensitivity of loan demand in response to monetary policy impulse providing that $\theta \neq \theta^\star$. Without adjustment cost or when $\theta = \theta^\star$, the response of loan demand to monetary impulse does not depend on capital. In the following, the focus will be on θ and γ_1 because of the main objective to analyse the effects of capital requirement and quality of institutions on monetary policy transmission.

Figure 2: Sensitivity of lending to monetary policy depending on γ_1 and ω

This graph shows the responses for $\frac{\partial \hat{l}_t}{\partial \hat{r}_t}$ according to different values of γ_1 and ω. $r = 5\%$, $L = 1$ and $\kappa = 0$. The main assumption here is that there is no capital adjustment costs.

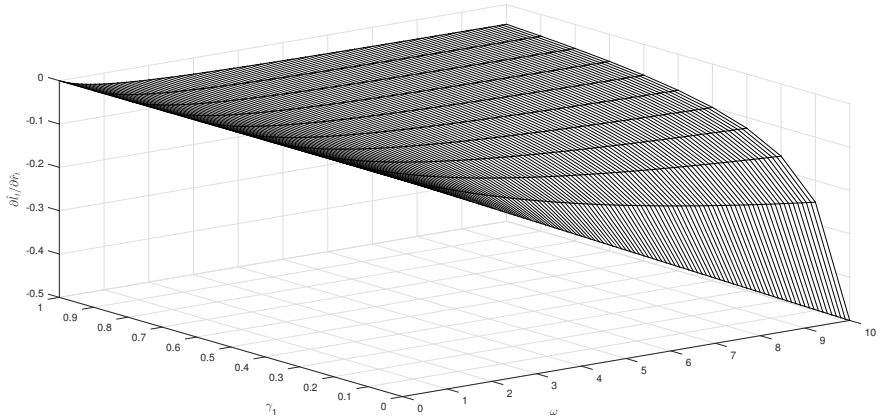
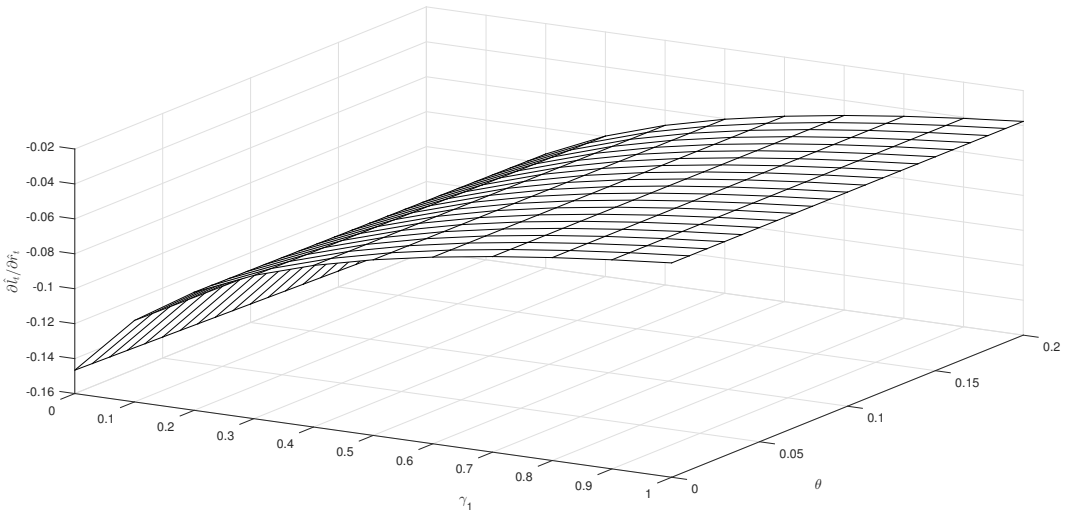


Figure 2 plots the responses of $\frac{\partial \hat{l}_t}{\partial \hat{r}_t}$ with the assumption that $\kappa = 0$. The responses become much more sensitive as γ_1 or ω increases. Larger intermediation cost due to institutional environment (increase of γ_1) or monopoly power of the bank (decrease of ω) reduces the effects of monetary policy. Lending rate linearly increases with the lending volume above the threshold $\underline{L}$ and proportionally to γ_1 (see equation (3)).

Figure 3 plots the responses of $\frac{\partial \hat{l}_t}{\partial \hat{r}_t}$ with respect to θ and γ_1 for given values of other parameters. Following a monetary tightening, banks further reduce the credit when the quality of the environment is deteriorating. Bank credit becomes less sensitive to monetary policy when θ and γ_1 increase.

Figure 3: Sensitivity of lending to monetary policy depending on γ_1 and θ

This graph shows the responses for $\frac{\partial \hat{l}_t}{\partial \hat{r}_t}$ according to different values of γ_1 and θ. $r = 5\%$, $L = 1$, $K/L = 8\%$, $\omega = 3$ and $\kappa = 5$.



3.3 Empirical predictions

Summing up the implications of capital requirement and quality of institutions for monetary policy transmission, three main hypotheses, presented in table 1, follow from the theoretical model:

1. An unfavourable environment reduces the effects of monetary policy or improving the quality of institutions strengthens the transmission of monetary policy.

2. Higher capital-to-assets target ratio increases the effects of monetary policy. As far as the regulator increases the capital requirement ratio, banks become capital constraint and therefore decrease lending much further in response to monetary tightening.

3. Smaller values of ω tend to reduce the degree of pass-through from policy rates to the lending volume. An increase in competition in the banking sector strengthens the effects of monetary policy.

Table 1: Main conclusion on the sensitivity of lending to monetary policy (in %)

This table simulates the responses for $\partial \hat{l}_t / \partial \hat{r}_t$ according to different values of γ_1 and θ. $r = 5\%$, $L = 1$, $K/L = 8\%$, $\omega = 3$. $\kappa = 0$ for the second column and $\kappa = 5$ for the others.

$\boldsymbol{\gamma_1}$	$\boldsymbol{\kappa = 0}$	$\boldsymbol{\kappa = 5}$ and following $\boldsymbol{\theta}$s				
		0	0.05	0.1	0.15	0.2
0	-15.00	-14.66	-14.80	-14.94	-15.09	-15.23
0.25	-8.57	-8.46	-8.51	-8.55	-8.60	-8.65
0.5	-6.00	-5.95	-5.97	-5.99	-6.01	-6.04
0.75	-4.62	-4.58	-4.60	-4.61	-4.62	-4.64
1	-3.75	-3.73	-3.74	-3.75	-3.76	-3.76

4 Empirical framework

In order to test the three hypotheses described above, interaction terms are used in a simple econometric framework as follows:

$$\Delta \log L_{i,j,t} = \mu_i + \alpha_t + \beta \Delta \log L_{i,j,t-1} + \varphi m_{t-1} + \zeta X_{i,j,t-1} + \gamma m_{t-1} X_{i,j,t-1} + \psi Z_{j,t-1} + \varepsilon_{i,j,t} \quad (6)$$

where $\Delta \log L_{i,j,t}$ is the growth of the total loans of bank i ($i = 1, \ldots, N$) in country j ($j = 1, \ldots, J$) at time t ($t = 1, \ldots, T$). m_{t-1} is the policy rate, $X_{i,j,t-1}$ a set of characteristics of the bank i at the period $t-1$ and $Z_{j,t-1}$ a vector of controls related to the country in which the bank operates. Lagged dependant variables, banks' specific effects (μ_i) and time effects (α_t) are introduced to take into account systematic variations in the growth of credit. α_t controls for unexpected variation or special events that may affect the bank lending. $\Theta = (\beta, \varphi, \zeta, \gamma, \psi)'$ is the vector of parameters to be estimated.

The presence of the lagged dependent variable in equation (6) suggests dynamic panel data estimation techniques. I use two-step GMM system estimation (Blundell and Bond, 1998) with robust standard deviation. The standard deviation of two-steps GMM is corrected with the procedure of Windmeijer (2005).

4.1 Monetary policy, capital, competition and quality of institutions measures

The repo rate is used as key measure of monetary policy mainly due to data constraint. In the description of the data, I also display summary statistics on one week interbank rate. As we could see on table 4, the standard deviation of the two rates are quite the same.

As regards to capital regulation, I use two measures to capture the banks' capital constraint: equity capital buffer to asset ratio (*Ebuffer*) and core capital buffer to asset ratio (*Cbuffer*). The first indicator is computed as the difference between the equity capital and the minimum capital divided by the total assets. The second indicator is defined as the difference between the core capital to-asset-ratio and the minimum Risk-weighted-assets ratio (8%). Positive (or higher) values of these indicators show that a bank meets the capital requirement. It is worth noting that capital to risk-weighted-asset ratio is the best measure of capital instead of core capital. However, this ratio is not calculated by the banks in their balance sheets. Moreover, the items of the balance sheets are already aggregated and it is not possible to properly calculate this ratio. For example, it is not possible to differentiate the maturity of some assets (less or more than 5 years) and also the type of securities (investment securities versus securities not resulting from securitization).

Competition will be proxied by three concentration indices: share of the three largest banks in terms of asset *CR3A*), Herfindhal-Hirschman Index (*HHI*) and income concentration ratio (*CR3I*). The first two indicators are widely used in empirical work. They originated in the structure-conduct-performance (SCP) paradigm. The last indicator is computed as the share of the three largest banks in terms of net income. It captures the industrial concentration and competition in the banking sector (Beck, Demirgüç-Kunt, and Levine, 2006).

The first measure of the quality of institutions used in this paper is "investment profile" (IP) of International Country Risk Guide (ICRG). It assesses the factors affecting the risk to investment that are not covered by other political, economic and financial risk components. I use also the regulatory quality index (RQ) for the country in which the bank operates as a second measure of the quality of institutions. The same indicator is used by Andrianova et al. (2015). This measure captures "perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development". Even if these indicators are not directly related to banking sector, there are related to investment and private sector development and they vary across countries and over time. The data from the bank regulation and supervision survey of the Word Bank may be used to measure the quality of institutions (see Cihak et al., 2012). However for some indicators of interest, there are no variation across the countries and over time (see table A.1 in appendix). The data shows that the regulatory framework and supervision are the same in all countries which is consistent with the regulatory framework. The indicators relating to the supervision and regulation of banking sector will poorly highlight differences in the credit behaviour.

4.2 Control variables

They are two kinds of controls added to the model: bank level and macro level. At bank level, liquidity and the size of the banks are added as control variables. These variables are found to be potential vectors of transmission of the monetary policy in the literature. Liquidity ($LIQUID$) is defined as the ratio of liquid assets to (sum of) short-terms liabilities. The regulatory framework requires that this ratio should at least 75%. The size of the banks ($SIZE$) is the log of the total assets.

At macro level, the willingness to lend may vary with the business cycle. I control for output gap which is a business cycle indicator and inflation. The output-gap ($OUTGAP$) is the cyclical component (of the natural log of) real gross domestic product obtained by applying the Hodrick-Prescott filter. This approach removes trends from time series variables. Inflation (INF) is measured by the annual variation of consumer price index.

Table 2 gives a summary of the variables, their description and sources of data. Banks variables are drawn from the balance sheets of the banks obtained from the Banking Commission of WAEMU, the banking sector regulatory arm of the Central Bank of the West African States (BCEAO) (available on the BCEAO website). Macroeconomic and institutional quality data are obtained from the BCEAO, the International Country Risk Guide (ICRG) and the World Bank's World Development Indicators (WDI) and World Governance Indicators (WGI) databases.

4.3 Data and descriptive statistics

I hand-collect the data from annual balance sheet reports of banks operating in the WAEMU region from 2000 to 2014. It is the unique dataset made available by the Banking Commission of WAEMU. This dataset is preferable to Bankscope data because it avoids the selection bias issue due to the fact that all the banks of the region do not necessarily report to Bankscope, whereas they all report to the Banking Commission of WAEMU.

Table 2: Description of the variables

This table presents the dependent and the explanatory variables in the equation (6), their definitions, the abbreviations used in empirical results, and sources of observed data.

Variables	**Description**	**Sources**
Repo	Monetary policy rate	BCEAO
Credit	Banks loans growth rate	BCEAO
Ebuffer	Difference between equity capital and minimum capital to asset ratio	BCEAO
Cbuffer	Difference between core capital-to-asset ratio and 8%	BCEAO
CR3A	Total assets of 3 biggest banks divided by total assets of all banks in the country	BCEAO
CR3I	Total net income of 3 biggest banks divided by total net income of all banks in the country	BCEAO
HHI	Herfindhal-Hirschman Index: sum of the square of the ratio of total assets of a bank divided by total assets of all banks in the country (market share in terms of assets)	BCEAO
IP	Investment profile	ICRG
RQ	Regulatory quality index	WGI
LIQUID	Liquid assets divided by short-term liabilities	BCEAO
SIZE	Log of the total assets	BCEAO
OUTGAP	Output gap: Cyclical component of the logarithm of real GDP	WDI
INF	Inflation: annual variation of consumer price index	BCEAO

Table 3 shows that the total number of banks 113. Actually, the number of banks in the region is 107 in 2014. This gap in the data is due to merger and acquisition. A bank over is considered over its existence period and I deal with the issues related to merger. Cote d'Ivoire (26) and Senegal (20) have the largest number of banks and they are also the two countries of lower-middle income in the region.

Table 3: Distribution of the sample

This table reports, for each of the WAEMU countries, the number of banks and the income level. The data for the number of banks are from the Banking Commission of WAEMU while the data on income levels are from the World Bank classification of countries for 2016.

	Income level	Number of banks	Number of observations
Benin	low	13	151
Burkina Faso	low	13	152
Cote d'Ivoire	lower-middle	26	273
Guinea-Bissau	low	4	40
Mali	low	13	172
Niger	low	11	132
Senegal	lower-middle	20	227
Togo	low	13	151
Total	-	113	1,298

Summary statistics including a correlation matrix are provided by tables 4 and 5. First, the mean of loan growth is 22% p.a. with a high dispersion (28.2%). The growth of credit is heterogeneous within the region but the region is dynamic in terms of lending even if the banking sector is small. In addition, the unconditional correlation between the repo rate (or the interbank rate) and the growth of credit is negative as expected but not significant. This is in the line with one strand of the literature on bank lending channel[4].

Second, the average Ebuffer and Cbuffer are positive meaning that the banks satisfy the minimum capital requirement and the risk coverage ratio. The positive average values of capital

[4]See for example Bernanke and Blinder (1988) *versus* Gertler and Gilchrist (1993).

buffers indicate that the banking sector is well-capitalized with high capital accumulation. As expected from the theoretical model, the unconditional correlation between capital and lending is positive and significant (at 1%). This results indicates that the banks will decrease their lending when they cannot satisfy the requirements. It should be noted that the minimum equity requirement is easier to be satisfied than risk coverage which involves banks' activities: more than 75% of the observations satisfy the minimum capital requirement while the proportion is much lower for the risk coverage ratio. The two measures of capital are positively correlated with lending.

Table 4: Summary statistics

This table reports the summary statistics for the dependent and explanatory variables of the system of three equations. The Q1, Q2 and Q3 are 25%, 50% (median) and 75% percentiles. The raw data for computing bank-specific variables were obtained from the Banking Commission of WAEMU, while the data for computing the rest of the variables were obtained from the BCEAO and the World Bank World Development Indicators and World Governance Indicators databases.

variable	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Q1**	**Q2**	**Q3**	**Max**
Repo	1,258	4.441	0.689	3.500	4.082	4.250	4.471	6.000
Interbank rate	1,199	4.205	0.678	3.268	3.768	4.212	4.516	6.167
Credit	1,258	0.216	0.282	-0.392	0.023	0.150	0.385	0.686
Cbuffer	1,258	0.003	0.072	-0.141	-0.033	-0.006	0.040	0.147
Ebuffer	1,258	0.048	0.060	-0.068	0.011	0.030	0.074	0.169
LIQUID	1,258	0.425	0.195	0.052	0.281	0.396	0.534	0.904
CR3I	1,138	0.194	2.659	-21.136	0.319	0.389	0.478	9.844
CR3A	1,258	0.553	0.092	0.398	0.473	0.554	0.621	0.805
HHI	1,258	0.146	0.038	0.091	0.115	0.142	0.170	0.289
IP	1,058	7.170	1.243	2.000	6.945	7.500	7.750	9.500
RQ	1,258	-0.786	0.366	-1.605	-1.111	-0.725	-0.526	0.021
TA	1,258	11.102	1.244	6.793	10.347	11.196	11.992	13.835
OUTGAP	1,258	0.000	0.012	-0.026	-0.006	0.002	0.007	0.021
INF	1,258	2.357	2.384	-3.100	0.732	2.157	3.572	7.797

Third, as regards to competition, the three largest banks (CR3A) hold, in average, 55.3% of the total asset of the banks in the region. This share reached 80.5% in Benin in 2001 but the average share in the region decreases over time from 62.51% (in 2000) to 52.10% (in 2014). This decrease is due to recent developments in the banking industry such as the increase of number of banks and expansion of the regional groups (Leon, 2016). The average value of HHI is less than 0.18 (a value that characterizes the more concentrated market according to US Anti-trust Agency). Two of the three concentration indices (HHI and CR3A) are positively correlated with bank lending. The correlation coefficients are not high but significantly different from zero. However the income concentration seems to corroborate the findings of the theoretical model as it is negatively correlate (but not significantly different to zero) to lending. The relationship between lending and competition may depend on the metrics used.

Fourth, the two measures of the quality of institutions are positively and significantly correlated with lending as expected form the theoretical model. In fact, higher values of these three indices imply an improvement of the quality of institutions (very low risk).

Finally, the correlation coefficients between the independent variables are not high as shown in Table 5 (less than 50%) except for one. In fact, the HHI and CR3A are highly correlated with a correlation coefficient of 95.4%. These indicators will not be simultaneously included in the regression. Except for these cases, the risk of multicollinearity is very low in this study.

Table 5: Pair-wise correlation matrix

This table reports the pair-wise correlation matrix for the dependent and explanatory variables of the equation (6). Values in parentheses are p-values which reflected the significance of each correlation. *** Significant at 1%; ** significant at 5%; and * significant at 10%.

Variables	Repo	Interbank	Credit	Cbuffer	Ebuffer	CR3I	CR3A	HHI	IP	RQ	TA	OUTGAP	INF	LIQUID
Repo	1.000													
Interbank	0.240***	1.000												
	(0.000)													
Credit	-0.039	-0.002	1.000											
	(0.229)	(0.954)												
Cbuffer	-0.002	-0.054	0.173***	1.000										
	(0.944)	(0.101)	(0.000)											
Ebuffer	-0.000	0.135	0.179***	0.350***	1.000									
	(0.999)	(0.000)	(0.000)	(0.000)										
CR3I	0.080**	0.121***	-0.028	-0.033	-0.010	1.000								
	(0.014)	(0.000)	(0.384)	(0.319)	(0.750)									
CR3A	0.226***	0.159***	0.093***	0.124***	0.072**	0.016	1.000							
	(0.000)	(0.000)	(0.004)	(0.000)	(0.027)	(0.630)								
HHI	0.271***	0.158***	0.094***	0.100***	0.088***	0.071**	0.954***	1.000						
	(0.000)	(0.000)	(0.004)	(0.002)	(0.007)	(0.029)	(0.000)							
IP	0.085***	0.090***	0.123***	0.129***	-0.045	0.023	0.323***	0.305***	1.000					
	(0.009)	(0.006)	(0.000)	(0.000)	(0.168)	(0.490)	(0.000)	(0.000)						
RQ	0.102***	0.055*	0.080**	0.118***	-0.029	-0.145***	0.329***	0.307***	0.465***	1.000				
	(0.002)	(0.094)	(0.014)	(0.000)	(0.369)	(0.000)	(0.000)	(0.000)	(0.000)					
TA	-0.030	-0.093***	-0.267***	-0.187***	-0.390***	-0.013	-0.275***	-0.266***	-0.084**	0.058**	1.000			
	(0.362)	(0.004)	(0.000)	(0.000)	(0.000)	(0.698)	(0.000)	(0.000)	(0.010)	(0.073)				
OUTGAP	-0.062*	0.153***	0.046	-0.033	0.041	-0.133	0.002	0.034	-0.113***	-0.003	0.008	1.000		
	(0.059)	(0.000)	(0.160)	(0.306)	(0.205)	(0.000)	(0.942)	(0.297)	(0.001)	(0.928)	(0.799)			
INF	-0.051	0.195***	-0.037	-0.032	0.091***	0.112***	-0.006	-0.000	-0.065**	-0.064*	0.003	-0.026	1.000	
	(0.118)	(0.000)	(0.256)	(0.323)	(0.005)	(0.001)	(0.850)	(0.995)	(0.048)	(0.050)	(0.930)	(0.427)		
LIQUID	0.237***	0.099***	0.077**	0.299***	0.175***	0.004	0.135***	0.168***	-0.032	-0.080**	-0.199***	-0.023	-0.051	1.000
	(0.000)	(0.002)	(0.018)	(0.000)	(0.000)	(0.900)	(0.000)	(0.000)	(0.322)	(0.014)	(0.000)	(0.476)	(0.116)	

5 Empirical results

I discuss in this section the effects of quality of institutions, capital regulation and competition on credit growth. I report the diagnostic statistics such as Hansen overidentifying restrictions tests and Arellano-Bond residual autocorrelation tests. The p-values of Hansen test are greater than 0.100 and one rejects (accepts) the first (second) order autocorrelation at 1% (10%). In general, the diagnostics statistics are satisfactory. In addition, the lagged dependent variable is significant in the regression. This last result indicates that the dynamic panel is appropriate. According to the econometric specification, the coefficient of the lagged dependent variable varies between 0.124 and 0.178, implying that the long-run effects of changes in other regressors are 1.14 to 1.22 as large as the short-run effects.

All the regressions are controlled for country effects and unexpected variation in bank lending by adding time dummies. I do not report those results in the regression tables to save space.

5.1 How sensitive is WAEMU banks' lending to monetary policy?

The focus of the paper is the effect of monetary policy on lending. Table 6 presents the main results. The repo rate is used as a proxy of the monetary policy. Column (1) shows the estimated effect of monetary policy on lending after controlling by bank size, bank liquidity, output gap and inflation. The result shows that the repo rate is negatively related to the growth of credit in WAEMU region. I find that, in the short run, 1% increase in policy rate decreases the growth rate of credit by 9.4 basis points. Columns (2) to (6) add other controls related to banks and institutions. The coefficients of monetary policy are still negative, slightly decrease to 8.4 basis points and fail sometimes to be significant.

This result is consistent with equation (5) and supports the view that monetary interventions do something special to banks via their balance sheet; in this case, their liabilities. In fact, a tight monetary policy increases uses of banks' internal funds following a decrease of the deposits: the coefficient of unconditional correlation between customer deposit and repo rate is 6% and significant at 10%.

5.2 Relationship between WAEMU banks' capital and lending

The literature suggests that the regulatory capital requirements induce banks to hold higher capital ratios than would otherwise have been by setting a capital cushion above the regulated minimum (e.g., Barrios and Blanco, 2003). To assess the effects of regulation on lending, I use the equity buffer to assets ratio as a measure of bank capital under the regulation. The results are reported in columns (2), (4) to (6) of table 6. I find that one percent increase in equity buffer to assets ratio increases bank lending up to 1.20 percentage points.

Therefore, when the level of bank capital decreases, banks reduce the level of credit granted especially when they are undercapitalized (negative buffer). If the regulation increases the level of minimum capital, this leads to a decrease in capital buffer and thus a decrease in the credit growth rate. The second phase of the increase in the level of minimum capital (up to 10bn CFAF) has already started in the WAEMU region with the deadline of 2017. If this new minimum capital was applied in 2014, the equity buffer ratio would have decreased by 4% (in

Table 6: Effect of monetary policy, capital, quality of institutions and competition on bank lending in WAEMU using Ebuffer as measure of capital

The regressions in this table examine the impact of monetary policy, capital, competition and quality of institutions on bank lending. The dependent variable is the growth rate of total amount outstanding. All the independent variables are lagged. The raw data for computing bank-specific variables were obtained from the Banking Commission of WAEMU, while the data for computing the rest of the variables were obtained from the BCEAO, the World Bank World Development Indicators and the International Country Risk Guide databases. All variables are defined in the table 2. Ebuffer#Repo, IP#Repo and HHI#Repo are interactions terms of Ebuffer, IP and HHI and repo rate. The estimations are performed using two-step GMM system method. All the regressions include country fixed effects and year dummies. Standard errors in parentheses are computed with the correction of Windmeijer (2005). *** Significant at 1%; ** significant at 5%; and * significant at 10%.

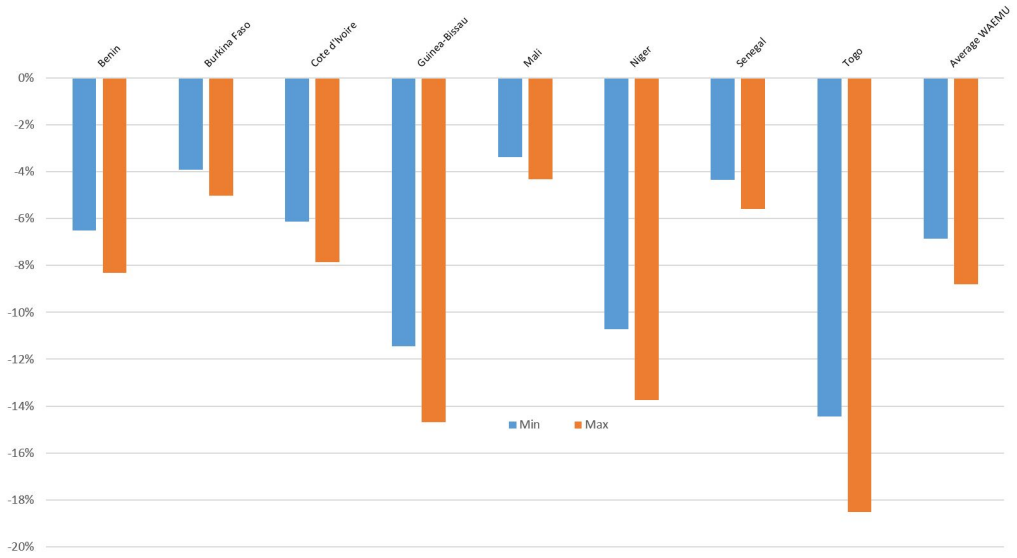
Dependent Variable	Bank loans growth rate					
	(1)	(2)	(3)	(4)	(5)	(6)
Lag of Credit	0.154***	0.169***	0.125**	0.156***	0.161***	0.124**
	(0.045)	(0.041)	(0.049)	(0.045)	(0.040)	(0.050)
Repo	-0.092***	-0.009	0.028	-0.084**	-0.082**	-0.094*
	(0.032)	(0.030)	(0.065)	(0.039)	(0.032)	(0.049)
Ebuffer		1.083***		0.845***	1.196***	1.101***
		(0.305)		(0.317)	(0.278)	(0.313)
Ebuffer#Repo					0.076	0.367
					(0.802)	(0.604)
IP			0.047**	0.063**		0.055*
			(0.023)	(0.029)		(0.031)
IP#Repo						-0.170***
						(0.051)
HHI				1.827*		2.224**
				(0.981)		(1.003)
HHI#Repo						-1.112
						(1.017)
SIZE	-0.180***	-0.082**	-0.081***	-0.127***	-0.091***	-0.124***
	(0.031)	(0.032)	(0.021)	(0.032)	(0.030)	(0.028)
LIQUID	-0.289**	-0.195	-0.018	-0.233	-0.210	-0.186
	(0.132)	(0.131)	(0.123)	(0.145)	(0.129)	(0.137)
OUTGAP	0.130	-1.144*	-0.704	-0.671	-1.303**	-0.349
	(1.050)	(0.587)	(0.929)	(0.512)	(0.525)	(0.534)
INF	0.013**	0.010*	0.007	0.012**	0.011*	0.011**
	(0.005)	(0.006)	(0.013)	(0.005)	(0.006)	(0.005)
Constant	2.080***	1.016***	0.699**	0.592	1.006***	0.487
	(0.367)	(0.374)	(0.323)	(0.419)	(0.348)	(0.412)
Time effects	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,114	1,114	1,114	1,114	1,114	1,114
Number of Id	112	112	112	112	112	112
Number of instruments	77	105	99	112	119	109
Hansen P-value	0.104	0.103	0.111	0.269	0.397	0.354
AR1 Residual Test	0.000	0.000	0.000	0.000	0.000	0.000
AR2 Residual Test	0.229	0.266	0.269	0.343	0.305	0.513

Mali) to 17% (in Togo) all things being equal. Therefore, credit growth would decline in the WAEMU by 19 percentage points in Togo and 3 percentage points in Mali, as plotted in figure 4. The average decrease of lending in the WAEMU would be 7 to 9 percentage points. Even if, in the short run, the increase in the level of minimum capital decreases bank lending, this increase allow the regulator to strengthen the banking system.

The theoretical model predicts that higher capital-to-assets target ratio increases the effects of monetary policy. To address this issue, I use the interaction between equity buffer ratio and

Figure 4: Change in lending following a decline in Equity buffer ratio

The graphs in this figure plot the change in lending following a decrease in Equity buffer ratio. The values are computed as follows: the estimated coefficients 0.845 (Min) and 1.083 (Max) are multiplied by the change in equity buffer ratio occur if the minimum capital of 10bn CFAF was applied in 2014.



repo rate. The result displayed in the columns (5) and (6) of table 6 do not show significant effect of the interaction term. However, because of non-linearity, the significance of the coefficients of the interaction variables cannot be evaluated by a simple t-test (e.g., Brambor, Clark, and Golder, 2006; Klomp and De Haan, 2010, among others). That is why, I compute the long-run effect for some values of equity buffer. I find that bank lending are less sensitive to monetary policy when the values of equity buffer ratio increase: after a tight monetary policy, bank lending decrease further for negative values of equity buffer ratio. The long-run sensitivity of lending to interest rate shock varies between -10.1 and -.9.42 basis points when the equity buffer ranges from -4% to +4%.

These results support the second prediction of the theoretical model and are in the line with one strand of the literature suggesting that bank capital could be a constraint to the lending activities (e.g., Kashyap and Stein, 2000; Kishan and Opiela, 2000, among others). According to this literature, the best capitalized banks should have a small extent reaction to the different monetary policies. In other words, the minimum capital regulation is an additional cost for the banks. As shown by previous works, under-capitalized banks are less able to collect deposits so as to either maintain or increase their credit supply during monetary restriction.

5.3 Do quality of institutions play a critical role?

The first prediction of the theoretical model suggests that an unfavourable environment reduces the effects of monetary policy or improving the quality of institutions strengthens the transmission of monetary policy. To test this hypothesis, I use investment profile as a measure of quality of institutions. The results are reported in columns (3), (4) and (6) of table 6.

First, in the short-run, the growth of bank lending due to an improvement in institutional quality varies between 4.7 and 6.3 basis points. This result is consistent with the fact that an

unfavourable environment involves additional costs and results in a decline in credit (Mishra and Montiel, 2013) or banks expand their credit supply once legal rights improve (Haselmann, Pistor, and Vig, 2010).

Second, I use an interaction term (policy rate and quality of institutions) to answer to the following question: to what extent do the institutions improve the transmission of monetary policy? The theory predicts a negative sign of the coefficient of interaction meaning that the quality of institutions improve or strengthens the transmission of monetary policy: smaller values of quality of institutions tend to reduce the degree of pass-through from policy rates to the lending volume. The results in column (6) of table 6 show that the quality of institutions improves the transmission of monetary policy as predicted by the model: after a tight monetary policy, bank loans will decrease further as the institutions are good. These results could be explained by bank lending behaviour in an environment of poor quality of institutions. In fact, when the quality of institutions are less good in the countries where the banks operate they lend more to large enterprises and to the government (Haselmann and Wachtel, 2010). This behaviour limits the cost of (soft) information collection relating to customers. In contrast, banks lend more to large firms and SMEs when the quality of institutions are good.

In the WAEMU region, about a third of credit to the economy is given to governments. In fact, over the period 2000-2011, the credit to the government ranges from 22.69% to 39.96% to the total credit to the economy. One also observed that those countries do not have a good performance in terms of quality of the institutions. The average of the regulatory quality is negative explaining why quality of institutions improves the transmission of monetary policy instead of weakening it.

5.4 How far is competition important for bank lending?

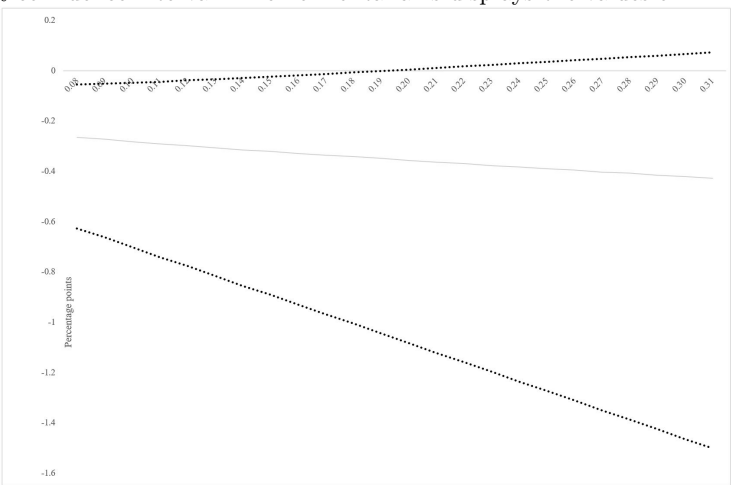
The third prediction of the theoretical model suggests that smaller values of ω reduce the degree of pass-through from policy rates to the lending volume or an increase in competition in the banking sector strengthens the effects of monetary policy. The competition in the banking sector is measured by the Herfindhal-Hirschman Index which is market power of the banks in terms of assets. The results are reported in columns (4) and (6) of table 6. I find that banking concentration increases the lending. One percent increases in market leads to an increase in lending by about 2 percentage points. This result is opposed to those of Beck, Demirgüç-Kunt, and Maksimovic (2004) who find that higher bank concentration is associated with more financing obstacles, especially for smaller firms. However, as mentioned by Cetorelli and Strahan (2006), banking market power is needed for banks to establish valuable lending relationships. This may explain why the market power in the WAEMU region is associated with high level of bank lending. The average credit growth rate of the small banks - total assets less than 50bn CFAF - is almost the double of those of big banks (total assets more than 200bn CFAF). But the average total outstanding amount of big banks is more than 14 times the average total outstanding amount of small banks. This facts show that more banks have high market power (in terms of assets), the more they lend.

In order to show the effect of competition on monetary policy transmission, I use the interaction terms between the policy rate and the concentration index. At first glance, these results

indicate that competition does not influence the transmission of monetary policy. However, as mentioned above, because of the non-linearity that makes that the t-test is not enough to interpret the interaction terms. The figure 5 shows that monetary policy is less effective for banks with higher market power. One percent increase in policy rate decreases the lending growth by 20.9 basis points, in average, for the banks with less market power. As the market power is increasing, the average decrease in lending growth falls to zero. This last finding supports the prediction of the model.

Figure 5: Long-run effect of policy rate on bank lending conditionally to HHI

This figure plots the reponses of lending following an increase in policy rate conditionally to HHI. The gray line is the estimated average value and the dotted lines are the bounds of the 95% confidence interval. The horizontal axis displays the values of HHI.



6 Robutness check

In this section, I check whether or not the previous results are sensitive to the metrics used to proxy capital, quality of institutions and competition. I use one other measure of capital (Cbuffer - Difference between core capital-to-asset ratio and 8%), one other measure of quality of institutions (RQ - Regulatory quality index), two measures of concentration (CR3A - Total assets of 3 biggest banks divided by total assets of all banks in the country and CR3I - Total net income of 3 biggest banks divided by total net income of all banks in the country) to study the robustness of the results. Table 7 reports the results of the estimations of the equation (6) when IP and RQ are used as measures of quality of institutions and CR3A, CR3I and HHI as measures of measures of competition. Table 8 presents the results by using capital buffer to assets ratio as measure of capital.

I find that capital is positively related to lending. One percent increases in capital leads to an increase in lending up to 2.2 percentage points (table 8). Furthermore, the well-capitalized banks are less sensitive to the monetary policy. These results confirm the previous findings.

Table 7: Effect of monetary policy, capital, quality of institutions and competition on bank lending in WAEMU using other measures of quality of institutions and competitions

The regressions in this table examine the impact of monetary policy, capital, competition and quality of institutions on bank lending. The dependent variable is the growth rate of total amount outstanding. All the independent variables are lagged. The raw data for computing bank-specific variables were obtained from the Banking Commission of WAEMU, while the data for computing the rest of the variables were obtained from the BCEAO, the World Bank World Development Indicators and the International Country Risk Guide databases. All variables are defined in the table 2. Ebuffer#Repo, IP#Repo, RQ#Repo, HHI#Repo, CR3I#Repo and CR3A#Repo are interactions terms of Ebuffer, IP, RQ, HHI, CR3I, CR3A and repo rate. The estimations are performed using two-step GMM system method. All the regressions include country fixed effects and year dummies. Standard errors in parentheses are computed with the correction of Windmeijer (2005). *** Significant at 1%; ** significant at 5%; and * significant at 10%.

Dependent Variable	Bank loans growth rate				
	(1)	(2)	(3)	(4)	(5)
Lag of Credit	0.098**	0.090*	0.124***	0.127***	0.108**
	(0.046)	(0.048)	(0.045)	(0.048)	(0.050)
Repo	-0.022	-0.027	-0.099**	0.086	0.009
	(0.036)	(0.039)	(0.048)	(0.163)	(0.056)
Ebuffer	2.022***	2.184***	1.211***	1.225***	1.175***
	(0.558)	(0.596)	(0.306)	(0.429)	(0.359)
Ebuffer#Repo			0.430	-1.462**	-0.636
			(0.870)	(0.711)	(0.744)
IP	0.057**	0.065**		0.085**	0.080**
	(0.026)	(0.026)		(0.041)	(0.034)
IP#Repo				-0.238***	-0.178**
				(0.075)	(0.070)
RQ			0.215*		
			(0.127)		
RQ#Repo			0.320		
			(0.323)		
HHI			0.296		
			(0.371)		
HHI#Repo			0.480		
			(1.181)		
CR3I	0.013				-0.011
	(0.093)				(0.097)
CR3I#Repo					-0.344
					(0.692)
CR3A		0.746*		0.807	
		(0.446)		(0.657)	
CR3A#Repo				-4.231	
				(3.160)	
Size	-0.067**	-0.060*	-0.115***	-0.138***	-0.130***
	(0.033)	(0.033)	(0.029)	(0.036)	(0.032)
LIQUID	-0.211	-0.164	-0.172	-0.210	-0.328***
	(0.147)	(0.129)	(0.149)	(0.143)	(0.118)
OUTGAP	-0.515	-0.946*	-1.288**	-0.640	-0.422
	(0.570)	(0.565)	(0.613)	(0.519)	(0.525)
INF	0.011	0.008	0.007	0.008*	0.010*
	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)
Constant	0.371	-0.324	1.296***	0.364	1.072***
	(0.437)	(0.540)	(0.390)	(0.653)	(0.398)
Time effects	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes
Observations	1,114	1,114	1,114	1,114	1,114
Number of Id	112	112	112	112	112
Number of instruments	93	99	109	45	69
Hansen P-value	0.170	0.233	0.170	0.381	0.191
AR1 Residual Test	0.000	0.000	0.000	0.000	0.000
AR2 Residual Test	0.671	0.732	0.412	0.428	0.569

As regard to the quality of institutions, I show that investment profile and regulatory quality are positively related to bank lending in WAEMU (tables 7 and 8). In addition, improving the quality of institutions strengthen the pass-through of policy rate to bank lending as predicted by the theoretical model.

Finally, as regard to competition, the results are mixed. The concentration indices do not seem to be good predictors of bank lending as suggested by Leon (2015) who analyses the effect of competition on SMEs access to financing. Banks' market power, measured by Herfindahl-Hirschman Index, is positively related to bank lending while the income concentration tends to decrease the growth rate of bank credit. The results are not robust to the addition of other control variables. Therefore, the sensibility of monetary policy transmission to competition depend on the metric used.

Apart from the key variables in the analysis, some others controls affect the bank lending. First, the size of the banks has a significant decreasing effect on bank lending. Small banks increase faster their lending compared to big banks. Second, banks tend to increase lending when the level of inflation increases. Third, liquidity and output-gap are weak determinants of bank lending in the WAEMU region.

Table 8: Effect of monetary policy, capital, quality of institutions and competition on bank lending in WAEMU

The regressions in this table examine the impact of monetary policy, capital, competition and quality of institutions on bank lending. The dependent variable is the growth rate of total amount outstanding. All the independent variables are lagged. The raw data for computing bank-specific variables were obtained from the Banking Commission of WAEMU, while the data for computing the rest of the variables were obtained from the BCEAO, the World Bank World Development Indicators and the International Country Risk Guide databases. All variables are defined in the table 2. Cbuffer#Repo, IP#Repo, RQ#Repo, HHI#Repo, CR3I#Repo and CR3A#Repo are interactions terms of Cbuffer, IP, RQ, HHI, CR3I, CR3A and repo rate. The estimations are performed using two-step GMM system method. All the regressions include country fixed effects and year dummies. Standard errors in parentheses are computed with the correction of Windmeijer (2005). *** Significant at 1%; ** significant at 5%; and * significant at 10%.

Dependent Variable	Bank loans growth rate							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lag of Credit	0.161***	0.138***	0.135***	0.087*	0.137***	0.100**	0.139***	0.078*
	(0.045)	(0.044)	(0.048)	(0.046)	(0.046)	(0.046)	(0.041)	(0.047)
Repo	-0.027	-0.063	-0.062	-0.047	-0.022	-0.105**	-0.051	-0.034
	(0.031)	(0.039)	(0.042)	(0.041)	(0.026)	(0.042)	(0.119)	(0.076)
Cbuffer	0.800**		0.670*	0.737**	0.678**	0.397	0.727**	0.698*
	(0.344)		(0.361)	(0.303)	(0.338)	(0.303)	(0.296)	(0.365)
Cbuffer#Repo					0.891*	1.169**	0.951*	1.108*
					(0.526)	(0.513)	(0.482)	(0.597)
IP			0.088***	0.048*			0.078***	0.076**
			(0.030)	(0.028)			(0.028)	(0.036)
IP#Repo							-0.183***	-0.194***
							(0.065)	(0.064)
RQ		0.227**				0.292**		
		(0.100)				(0.147)		
RQ#Repo						-0.194		
						(0.358)		
HHI			1.658*			0.457		
			(0.931)			(0.365)		
HHI#Repo						0.881		
						(1.471)		
CR3I				-0.005*				0.094
				(0.003)				(0.107)
CR3I#Repo								-0.206
								(0.932)
CR3A							0.401	
							(0.437)	
CR3A#Repo							0.099	
							(2.241)	
Size	-0.129***	-0.089***	-0.160***	-0.114***	-0.150***	-0.150***	-0.123***	-0.151***
	(0.031)	(0.025)	(0.027)	(0.027)	(0.031)	(0.028)	(0.032)	(0.037)
LIQUID	-0.212	-0.051	-0.184	-0.296*	-0.240*	-0.152	-0.213*	-0.220*
	(0.142)	(0.120)	(0.126)	(0.158)	(0.123)	(0.120)	(0.124)	(0.131)
OUTGAP	-0.769	-0.788	-0.553	-0.205	-0.741	-1.156**	-0.832	-0.361
	(0.540)	(0.714)	(0.518)	(0.561)	(0.598)	(0.525)	(0.552)	(0.545)
INF	0.011**	0.010	0.008	0.015**	0.009*	0.008	0.012**	0.012**
	(0.006)	(0.010)	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)	(0.006)
Constant	1.597***	1.110***	0.894**	1.110***	1.856***	1.749***	0.657	1.247**
	(0.351)	(0.281)	(0.412)	(0.340)	(0.344)	(0.370)	(0.485)	(0.531)
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,114	1,114	1,114	999	1,114	1,114	1,114	1,114
Number of Id	112	112	112	112	112	112	112	112
Number of instruments	105	99	105	114	98	119	111	53
Hansen P-value	0.174	0.120	0.297	0.176	0.147	0.492	0.145	0.140
AR1 Residual Test	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR2 Residual Test	0.222	0.198	0.355	0.536	0.364	0.446	0.386	0.695

7 Conclusion and policy implications

It has been suggested that an increase in capital adequacy ratio reduces the ability of banks to lend particularly if they decide to hold more capital. In developing countries, this behaviour may be strengthened by the low quality of institutions and the concentration of the banking sector. Altogether, these factors may impaired the transmission of monetary policy.

In this paper, I explore in a simple partial equilibrium theoretical model based on adjustment and intermediation costs and find that 1) loan demand depends negatively on the policy rate, 2) improving the quality of institutions and an increase in competition strengthen the transmission of monetary policy and 3) as far as the regulator increases the capital requirement ratio, banks become capital constraint and therefore decrease lending much further in response to monetary tightening.

Estimation of an econometric model based on hand collected data banks of WAEMU region confirms this result: 1) bank lending is sensitive to monetary policy, 2) a capital-constrained bank reduces further its lending following a tight monetary policy as compared to a less capital-constrained bank, 3) poor institutions weaken the transmission of monetary policy while an improvement in the quality of institutions seems to strengthen it, and 4) monetary policy is less effective for banks with high market power.

These empirical results are consistent with the growing literature on the effects of (capital) regulation on lending regulation (e.g. Berrospide et al., 2016; Cerutti, Claessens, and Laeven, 2015; Ongena, Popov, and Udell, 2013; Van den Heuvel, 2006, among others). They suggest that a hightening of capital leads to shifts in lending. In addition, they are consistent with another strand of the literature which show that the less capitalized banks accelerate the transmission of monetary policy (e.g., Kashyap and Stein, 2000; Kishan and Opiela, 2000; Levieuge, 2005, among others). Finally, the findings are related to the literature which support that poor quality of institutions weak the transmission of the monetary policy pass-through (e.g., Mishra and Montiel, 2013; Mishra et al., 2014, among others).

In terms of policy implications, the results imply that policymakers in the WAEMU region have substantial room to affect bank lending. In fact, a tight monetary policy decrease bank lending. That means that the Central Bank could decrease the policy rate to boost bank lending. From 1998 to 2012, the policy rate lied between 4% to 6%. The Central Bank decided to decrease the policy rate in early 2013 *to boost the recovery of the Union's economic activity* by stimulating lending. Moreover, the WAEMU bank regulatory authorities must bear in mind that the increase in minimum capital affects bank lending and can therefore affect bank profitability. Finally, there is also a message for governments of WAEMU's member states and international donors. As stated by Andrianova et al. (2015), *very weak legal systems do deter banks from lending, but mediocre ones do not. Reaching the international average is an appropriate goal for Africa and incremental steps towards this goal can be beneficial.* In this vein, improving the business environment in Cote d'Ivoire, in terms of reforms, is encouraging and should be extended to the other countries in the region.

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A Appendix

Table A.1: Indicators from Bank Regulation and supervision dataset

	Year	Min	Mean	Max	Standard deviation
Overall Restrictions on Banking Activities	2003	7.00	7.00	7.00	0.00
	2007	8.00	8.00	8.00	0.00
	2012	7.00	7.00	7.00	0.00
Entry into Banking Requirements	2001	8.00	8.00	8.00	0.00
	2003	8.00	8.00	8.00	0.00
	2007	8.00	8.00	8.00	0.00
	2012	8.00	8.00	8.00	0.00
Initial Capital Stringency	2001	3.00	3.00	3.00	0.00
	2003	2.00	2.00	2.00	0.00
	2007	2.00	2.13	3.00	0.33
	2012	3.00	3.00	3.00	0.00
Capital Regulatory Index	2001	7.80	7.80	7.80	0.00
	2003	7.00	7.00	7.00	0.00
	2007	6.00	6.88	7.00	0.33
	2012	7.00	7.00	7.00	0.00

Source: Milken Institute.