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Financial Sector Competition in West African Economic and Monetary Union

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Abstract

This paper investigates the degree of competition in the WAEMU financial industry over the period 2002-2007 using firm-level data (591 year-firm observations). Market structure analysis, the Panzar-Rosse model and conjectural variation are applied to assess the level of competition. The results show that the prevailing market structure in the WAEMU financial industry is concentrated and financial intermediaries operate under imperfect competition. Although competition was fierce during the mid-2000s, the level of competition has remained limited. Moreover, apart from Benin and Mali, the structural and non-structural approaches are closely related, contrary to previous findings, which have some implications for the empirical studies. Finally, a common regulatory framework does not imply similar level of competition. The presence of non-legal barriers is the most plausible explanation of these large differences between WAEMU members.

Key words : Banking competition, Market structure, Panzar-Rosse model, Conjectural variation model, WAEMU

JEL codes : D4, G21, L11, L13, O55

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1 Introduction

Africa remains today one of the most financially under-developed parts of the world. Recent decades have seen a remarkable increase in the number of financial reforms in Africa. A main reason for these reforms was to make the financial sector more competitive. Studies of competitive bank conditions, its determinants and its effects, in the developed countries are commonplace. However, there have been relatively few studies conducted in the Low Income Countries (LIC) and in particular in Sub-Saharan Africa (SSA) and no empirical work for the West African Economic and Monetary Union (WAEMU) has been done.

This paper assesses the level of bank competition in the WAEMU. Contrary to other studies, all financial intermediaries are included in our database [1]. The sample considers 111 firms in 7 countries over the period 2002-2007. We use two main approaches to measure bank competition : the structural and the non-structural approach. The first one assesses bank competition by examining market structures. Market structures take into account the importance of (legal and non-legal) barriers of entry and exit into the market. We consider the most frequently applied measures of concentration namely the 3-bank concentration ratio (CR3) and Herfindahl-Hirschman Index (HHI). The non-structural approach focuses on the behavior of banks. We use two non-structural approaches : the H-statistic created by Panzar and Rosse [1982, 1987] and the conjectural variations (CV) model developed by Iwata [1974] and Appelbaum [1982].

The most important results are as follows : Although competition was fierce during the mid-2000s, the level of competition remains limited in WAEMU. In SSA, only the CEMAC and Botswana financial sectors are less competitive. Moreover, apart from Benin and Mali, structural and non-structural approaches are closely related contrary to previous findings [Claessens and Laeven, 2004]. Hence, concentration seems to be a good proxy to competition environment for LIC although adaptationsshould be implemented [Degryse et al., 2009]. Finally, a common regulatory framework does not necessarily imply the same level of bank competition. Legal barriers are not as crucial to explain bank competition

1. The Fitch Bankscope Database is used in the majority of developing country bank sector research. However, this dataset neglects many small and local-private owned banks or specific information is not available (for instance, the number of employees).

differences in LIC. Non-legal barriers account for a large part of bank competition and liberalization is not sufficient to promote bank competition in LIC [Delis, 2012].

The structure of the rest of paper is as follows : Section 2 provides a background to the financial system in the WAEMU countries. Section 3 discusses measures of market structure. Section 4 presents the empirical results with the H-statistics. Section 5 shows the results with the conjectural variation approach. The final section concludes.

2 Overview of the WAEMU banking system

The WAEMU financial sector has dramatically changed during the two last decades, it has been liberalized and developed [2]. Until the beginning of the 1990s the banking system was highly administrative. This policy did not yield the expected results. Worse, it caused the banking crisis at the end of the 1980s and early 1990s [Daumont et al., 2004]. Following the financial distress, reforms were put in place by the monetary authorities. Insolvent banks were liquidated or privatized. A regulatory institution, called the banking commission (COBAC), was created in 1990. This commission ensures the supervision of bank activity and the compliance with legislation. In addition, interest rates and credit distribution became market-determined to mobilize the funds and improve the allocation of capital. Since reforms, political interventions have been reduced and the sector is now largely liberalized. Liberalization should lead to fiercer competition within the banking system.

Over the last decade, financial activity, as well economic activity, has grown. Nonetheless, the WAEMU financial system is still small and relatively underdeveloped. The financial depth in WAEMU remains very limited as the ratio of credit to the private sector and bank branch penetration highlighted. The ratio of credit to the private sector represents only 13% of GDP in the WAEMU, lower than in other SSA countries (17%) and other developing countries (between 30% and 50%). The demographic and geographic branch penetration is inferior in WAEMU compared to the majority of SSA countries

2. In all this section, when the sources of data are not clearly mentioned, the data come from the COBAC annual reports (COBAC [2002–2009]) and the BCEAO website (`www.bceao.int`). All calculations are made by the author.

(see Appendix A : Figure 2) [3]. Moreover, the majority of bank-branches are concentrated in the (economic) capitals [4]. Within WAEMU, Niger and Guinea-Bissau are the least financial developed countries.

The degree of product concentration, maturity structure, concentration of customers, and price of financial services are other issues (see Appendix : Table 10). The main services provided by financial intermediaries are the collection of resources from economic agents, who have financial excess and provide loans to those who need financing. Apart from Senegal and Togo, other services such leasing, factoring or securities represent less than ten percent of total assets. Moreover, banks rarely provide long-term financing. The loans of which maturity exceeds five years represent less than 5% of total loans. On the contrary, more than two thirds of loans are short-term ones. Concerning the allocation of loans by sector, the majority of resources are allocated to the services and trade sector (see Appendix : Figure 3). More than one third of loans to the private sector are allocated to the trade and tourism sector, less than one quarter to the secondary sector (manufacturing and extractive industries), and only 3% to the primary sector (mainly agriculture). This allocation is largely unrelated to economic structure which is mostly dominated by agriculture. These features shed light on the bank preference for liquidity and low-risk assets. The analysis of the price of financial services and the cost of financial intermediation confirms this conclusion. According to Beck et al. [2010] data, the net interest margins in WAEMU are lower than ones in other Sub-Saharan Countries and Asia (See Appendix : Figure 4). The most plausible explanation is the prudential behavior of banks that implies a low risk-premium. However, risk-aversion behavior of banks penalizes SME and private sector development.

As many other SSA financial systems, the financial sector in WAEMU is dominated by banks. Banks represent more than 80% of financial institutions and more than 95% of assets. There are currently about one hundred financial institutions formally approved in WAEMU. The financial sector is mostly foreign-owned (see Table 1). At the regional level,

3. Calculations are based on the Beck et al. [2007] methodology and no-WAEMU data comes from Beck et al. [2007].

4. In 2007, two thirds of bank branches were located in the capitals.

TABLE 1 – Ownership structure (% of capital)

	Benin		Burkina-Faso		Ivory Coast		Guinea-Bissau	
	2000	2010	2000	2010	2000	2010	2000	2010
Domestic	31.7	31	51.2	43.7	51.3	56.5	41	52.4
- *State*	5.9	2.0	19.0	20.0	23.4	26.1	9.6	0.0
- *Private*	25.8	29.0	32.2	23.7	27.9	30.4	31.4	52.4
Foreign	69.3	69	48.8	56.3	48.7	43.5	59	47.6
- *WAEMU*	NA	23.8	NA	11.7	2.7	9.2	NA	25.5
- *No WAEMU*	NA	45.2	NA	44.6	46	34.3	NA	22.1

	Mali		Niger		Senegal		Togo	
	2000	2010	2000	2010	2000	2010	2000	2010
Domestic	53.8	43.3	49.6	31.7	45.7	28.1	33.0	52.2
- *State*	33.4	23.5	28.6	7.7	14.9	5.3	20.9	29.8
- *Private*	20.4	19.8	21.0	24.0	30.8	22.8	12.1	22.4
Foreign	46.2	56.7	50.4	68.3	54.3	71.9	67	47.8
- *WAEMU*	0.0	2.7	NA	9.3	NA	5.9	NA	22.2
- *No WAEMU*	46.2	54.0	NA	59	NA	66	NA	25.6

Source : COBAC annual reports, Author's calculations.

the average foreign share of bank capital is about 60%, while private local share is around 20%. Government ownership of banks in WAEMU is limited, only one fifth of capital is owned by the State, and it has declined since the reforms in the 1990s. These features are more pronounced for Benin and Senegal which have a foreign and a private-owned system.

Regarding the ownership structure, another feature is important. A few number of holdings dominate the market. More than three-fifth of assets, branches, accounts and staff are in the hands of the seven biggest holdings, while they account for only one third of banks. The major holding is Ecobank (its market share is 14.8%) followed by Société Générale (12.9%), BOA Group (10.7%), Attijariwafa Bank (10.3%), BNP Paribas (8.5%), AFG (5.5%) and United Bank for Africa (2.6%). Ten more small holdings play a role in the market : BSIC, Lybian Foreign Bank, Citibank, BRS, BID, Financial BC SA, COFIPA, Standard Chartered BV, Access bank Pic and Alios Finance. They control another third of bank and less than ten percent of assets and branches.

African groups are more active than non-African ones [5]. This feature emphasizes the

5. The market share of African holdings has increased during the last decade. They expand their

attractiveness of WAEMU market for African banks and might change the financial landscape in the future. Future research should take into account modifications implied by this trend.

3 Literature review

The literature regarding the assessment of competitive behavior is divided into two main streams : the structural and the non-structural approaches. The first one tries to assess the concentration in the market while the second one describes the observed behavior of firms.

The structural approach is based on the *Structure-Conduct-Performance paradigm* (*SCP-paradigm* henceforth) developed by Mason [1939] and Bain [1956]. The competitive features of industry are inferred from structural characteristics which influence firm behavior and performance. According to *SCP-paradigm*, structures influence conduct (e.g. a more concentrated market leads to a more collusive behavior by the firms) and conduct influences performances (e.g. less competitive behavior leads to higher price, lower quantity, abnormal profit and hence lower social efficiency). In other words, the *SCP-paradigm* argues that bank concentration implies uncompetitive behavior by firms. Hence simple measures of concentration are exogenous indicators of the intensity of competition. Theoretically and empirically there are many problems with *SCP-paradigm* and concentration measures [6]. Two main industrial organization theories investigate whether *SCP-paradigm* is biased. Firstly, the efficiency structure (ES) hypothesis shows that structure is not necessarily exogenous [Demsetz, 1973, Peltzman, 1977]. According to ES hypothesis, market structure itself is affected by firms' conduct and performance. Secondly, the theory of contestability, developed by Baumol et al. [1983], investigates in another way whether concentration might be biased indicators of competitive environment. In a contestable

network in WAEMU by de novo implantation (for example UBA) or by the acquisition of existing bank (for instance Attijariwafa which took the control of IUB holding in Ivory Coast and Senegal). At the same time, the market share of the non-African groups has declined during the last five years. In 2005, Société Générale and BNP Paribas were the two major holdings (second and fifth currently). Other non-African holdings have left the market, for example, Belgolaise or Credit Lyonnais.

6. All critics are not exposed : For more details see Berger et al. [2004] and Degryse et al. [2009].

market, which is characterized by the threat of entry, a firm is unable to raise its prices above marginal cost. Thus a high concentrated market can be competitive if firms can enter and exit freely the market.

In reaction to the deficiencies of the structural measures, non-structural approaches of competitive behavior were developed in the 1980s. The aim was to obtain a direct measure of the firms' behavior. Two non-structural models are largely used in bank competition literature [7] : the conjectural variations model and the H-statistics model. Both are based on a static theory of the firm models under equilibrium conditions and need detailed information on firms. The conjectural variation model is based on the idea that a firm when choosing its output takes into account the reaction of rival firms. On the contrary, the H-statistics model does not consider interactions between firms but focuses on the reaction of firms when input prices are changing.

Empirical studies of the conjectural variations in banking have been applied to developed countries. Applications to developing and in particular to African countries are scarce : Biekpe [2011] applies this method to Ghana, Mwega [2011] to Kenya and Zhao and Murinde [2011] to Nigeria. No clear-cut feature emerges and the results depend on the sample and method used.

The H-statistic suggested by Panzar and Rosse [1982, 1987] is another frequently used approach. The Panzar and Rosse model allows the obtaining of the identification of a competitive environment through a parameter (the H-statistic). The H-statistic is the sum of the elasticities of the revenues of the firms with respect to their factor input prices. Contrary to the conjectural variation model (which requires detailed information on cost and demand), the H-statistic only needs revenues and factor prices data [8]. Many studies have applied the Panzar and Rosse methodology to banking in developed countries (see Bikker et al. [2011] for a broad review). Apart from Japan and Italy, developed countries are characterized by a monopolistic competition structure. A growing part of

7. Other non-structural models exist such as the Boone indicator [Boone, 2008] or the persistence of profit indicator [Goddard and Wilson, 1999]. We ignore the other models which are rarely used in banking literature and require panel data with high temporal dimension.

8. Shaffer [2004] presents a detailed analysis concerning of the advantages and disadvantages of the two NEIO tests.

TABLE 2 – Summary of published empirical P-R studies on SSA banking industry

Country	Period	H-statistic	Number of Banks	Obs	Author(s)
Botswana	1990-2004	0.23	6	50	Bikker and Spierdijk [2008]
CEMAC	1993-2004	0.27	32	148	Saab and Vacher [2007]
Uganda	1999-2002	0.30	15	196	Hauner and Peiris [2005]
	2002-2004	0.49	15	97	Hauner and Peiris [2005]
Zambia	1990-2004	0.53	8	57	Bikker and Spierdijk [2008]
	1999-2008	0.83	11	440	Mwenda and Mutoti [2011]
Ghana	1998-2003	0.56	13	65	Bikker and Spierdijk [2008]
	1991-2004	0.61	15	87	Buchs and Mathisen [2005]
	2001-2007	0.66	17	119	Biekpe [2011]
Mauritius	1991-2004	0.58	12	50	Bikker and Spierdijk [2008]
Kenya	1994-2001	0.58	34	106	Claessens and Laeven [2004]
	1989-2004	0.62	38	188	Bikker and Spierdijk [2008]
Tanzania	2004-2008	0.66	26	101	Simpasa [2011]
Nigeria	1994-2001	0.67	42	186	Claessens and Laeven [2004]
	1989-2004	0.74	63	319	Bikker and Spierdijk [2008]
South Africa	1994-2001	0.85	45	186	Claessens and Laeven [2004]
	1987-2004	0.54	32	189	Bikker and Spierdijk [2008]

Note : The market is characterized by a collusive situation if $H \leq 0$; by a monopolistic competition if $0 < H \leq 1$; and by a perfect competition situation if $H = 1$.

literature concerns the emerging countries from Latin America, Asia and MENA. The papers stress that most banking sectors in MENA operate under a monopolistic competition structure [9]. Empirical evidences from Latin America and Asia are more diverse although the situation of monopolistic competition or perfect competition dominates remains [10]. Empirical investigations in Sub-Saharan Africa are scarce because bank data are rarely available. The table 2 sums up the existing literature concerning SSA banking system which is best characterized by monopolistic competition.

We propose to measure competition in WAEMU financial sector by using both structural and non-structural approaches. As far as we know, it is the first study applied to WAEMU countries.

9. See : Al-Muharrami et al. [2006], Turk-Ariss [2009] and Anzoategui et al. [2010].
10. See : Gelos and Roldos [2004], Yeyati and Micco [2007], Olivero et al. [2010].

4 Market structure analysis

The data has been obtained from annual individual bank balance sheets and income statements of financial institutions published in COBAC's annual reports (COBAC [2002–2009]). This study covers all (bank and non-bank) financial institutions in WAEMU over the period 2002-2007. The final unbalanced data sample consists of 591 bank-year observations [11].

Concentration measures give a view of entry and exit barriers in the market. k-bank concentration ratio (CRk) and Herfindahl-Hirschman Index (HHI) are the most frequently used measures of concentration. Both require limited data and are easily computable and understandable. CR3 is the sum of the market share (s_i) of the three largest banks in the market, it takes the form :

$$CR3 = \sum_{i=1}^{3} s_i, \quad with \quad s_1 \geq s_2 \geq s_3 \geq s_j, \quad \forall j \geq 4 \tag{1}$$

The index approaches zero (minimum value is $100 * (3/n)$, with n the number of firms in the industry) for an infinite number of equally sized firms and it equal to 100 if the firms included in the calculation make up the entire industry.

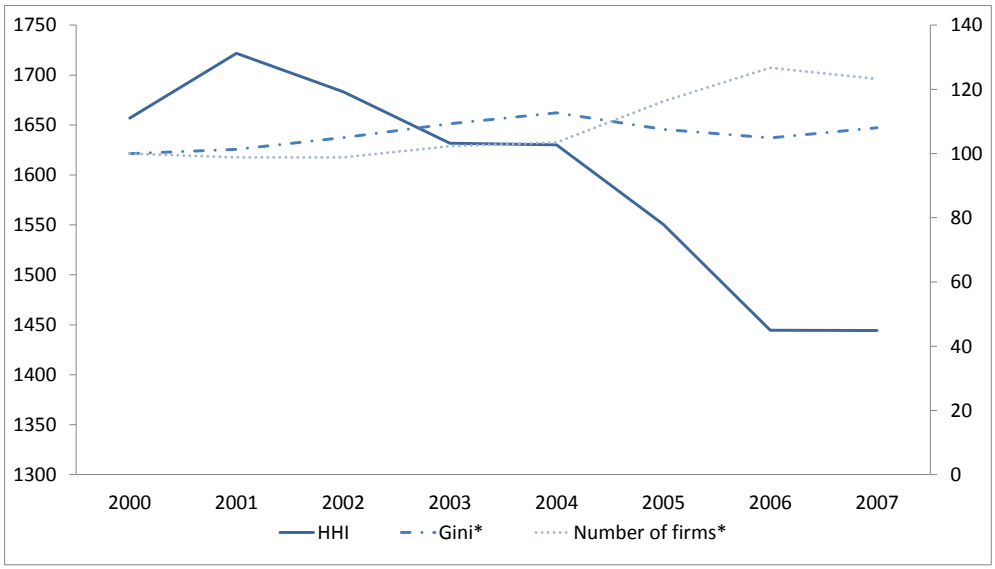
HHI is the most frequently used concentration measure by researchers and bank regulatory agencies. Algebraically, it takes the form :

$$HHI = \sum_{i=1}^{n} s_i^2, \quad \forall i = 1, \ldots, n \tag{2}$$

HHI captures the entire distribution of firm sizes. HHI is sensitive to its two constituent parts ; *(i)* the number of firms, and *(ii)* the inequality in market shares among the different firms. The HHI index ranges between $100 * (1/n)$ (for equally sized firms) and 10000 (for a monopoly). According to previous studies and current screening guidelines in the USA, the banking industry is regarded to be a competitive market if the HHI is less than 1000, a somewhat concentrated market if the HHI lies between 1000 and 1800, and a very concentrated market if HHI is more than 1800.

11. All financial figures are expressed in 2000 FCFA.

FIGURE 1 – Evolution of HHI and its components



Note : * base 100 = 2000 ; Guinea-Bissau is excluded

The total assets have been taken as the measure of bank size to compute the *CR3* and the HHI [12]. Both concentration measures show that the WAEMU banking sector is moderately concentrated. Concentration in the WAEMU was reduced during the 2000s with a break in 2005 (cf Figure 1). Two elements can explain this trend : the number of firms and the firm size distribution (Bikker and Haaf [2002b]). In order to distinguish between both, we compute the number of firms and the Gini coefficient evolutions (base unit=2000) [13]. The number of firms has increased from 86 in 2000 to 116 in 2007. It was stable until 2004 (90 banks operated in 2004) and increased sharply since 2005. At the same time, the Gini coefficient has remained relatively stable over the period. The distribution of the market share did not dramatically change during the 2000s. Thus, the HHI decline is largely explained by the opening of new banks since in the mid-2000s.

Within the WAEMU, four groups can be distinguished (cf. Table 5) : (i) The market

12. Using the total deposits or total loans does not significantly change the results and conclusions.

13. The Gini coefficient is a measure of the inequality of distribution, a value of 0 expressing total equality and a value of 1 maximal inequality. Contrary to concentration measures, the Gini coefficient has two main characteristics : scale independancy and population independancy.

TABLE 3 – Levels of concentration by country

	Average		2000		2007		Market Structure
	CR3	HHI	CR3	HHI	CR3	HHI	(level of concentration)
Benin	71.12	2296	78.33	2671	64.41	1827	High
Burkina-Faso	55.65	1521	66.93	1947	48.10	1827	Moderate
Ivory Coast	48.03	1150	51.33	1299	42.91	1021	Low
Guinea-Bissau	98.17	6551	100[a]	10000[a]	94.06	3427	Very high
Mali	58.85	1744	54.53	1506	54.62	1428	Moderate
Niger	68.45	1931	71.28	2015	64.57	1781	High
Senegal	57.89	1444	54.90	1445	60.43	1467	Moderate
Togo	58.50	1519	56.64	1458	60.76	1592	Moderate

[a] *Data for 2001*

concentration is low in Ivory Coast ; (ii) Senegal, Burkina-Faso, and Togo are moderately concentrated ; (iii) Benin, Mali, and Niger are heavily concentrated ; (iv) Guinea-Bissau is a singular country with a young banking system (only one bank operated until 2005). Apart from Guinea-Bissau, the levels of concentration in WAEMU members were moderate in 2007, comparatively to other SSA and MENA countries (see : Appendix Figure 5).

5 Panzar and Rosse model : The H-statistic

5.1 Methodology

The Panzar and Rosse [1982, 1987] model (PR henceforth) is the most commonly used test of the degree of competition. The test is based on reduced-form revenues function and identifies the market structure of the industry. The H-statistic, which measures the level of competition, is the sum of the elasticities of total revenues of the firm with respect to its input prices and its values ranging from $-\infty$ to $+1$. Under the long-run competitive equilibrium, H-statistic is equal to unity. By contrast, H-statistic will be zero or negative if the firm operates as a monopoly. Finally, if the market is characterized by monopolistic competition, the H-statistic will lie between zero and one. According to Panzar and Rosse

[1987], not only the sign of the H-stastic matters, but also its magnitude [14].

A number of working assumptions are required to apply the PR approach to banks (or financial institutions). Banks must be treated as single product firms and inputs are homogenous [15]. Moreover, the demand elasticity has to be superior or equal to one. Last but not least, banks should be observed from a (long-run) equilibrium perspective (Shaffer [1982]).

5.2 Data and econometric specification

We use the same dataset to perform our first empirical test, the Panzar and Rosse H-statistic. However, contrary to the previous section, some filtering rules are applied [16]. Guinea-Bissau is omitted because only 8 bank-year observations are available. This reduces the sample to an unbalanced panel of 7 countries consisting of 110 banks (484 bank-year observations) for the period 2002-2007.

For bank i at time t, the revenues function to be estimated is the following :

$$\log(R_{i,t}) = \beta_1 log(w^L_{i,t}) + \beta_2 log(w^F_{i,t}) + \beta_3 log(w^K_{i,t}) + \gamma_1 risk_{i,t} + \gamma_2 equity_{i,t} + \gamma_3 deposit_{i,t} + \gamma_4 onea_{i,t} (+\gamma_5 size_{i,t}) + \alpha_i + \mu_t + \epsilon_{i,t} \quad (3)$$

where the subscript i denotes bank and the subscript t denotes year. The H-statistic is the sum of the input price elasticities : $H = \beta_1 + \beta_2 + \beta_3$. Dependent variable $[log(R_{i,t})]$ is the natural logarithm of total income that includes interest and non-interest revenues. Following previous studies, the model chosen is the intermediation one (Sealey and Lindley

14. Shaffer [2004] casts doubt on the use of the H-statistic as a continuous measure of competition although Vesala [1995] proves that the H-statistic is a continuum under certain conditions. In empirical studies, Bikker and Haaf [2002a] and Claessens and Laeven [2004] consider it as a continuum. In order to compare competition levels, we consider the H-statistic as a continuum. However, the results have to be treated with caution.

15. In other words, higher input prices cannot be correlated with higher quality services that generate higher revenues.

16. Firstly, to avoid outliers, we drop observations where prices and/or average cost are not comprised between the 1-st and 99-th percentile. Secondly, we drop observations in which one of the dependent variables (total revenues and ROA) or independent variables are not available. Finally, we exclude observations if prices of inputs, total assets, deposits, loans or equity is negative.

[1977]). We consider three inputs : labor, funds and physical capital. The price of labor ($w^L_{i,t}$) is measured by the ratio of personnel expenses to the total number of employees, the price of funds ($w^F_{i,t}$) by the ratio of interest expenses to total funds, and the price of physical capital ($w^K_{i,t}$) by the ratio of other expenses (operational and depreciation) to total fixed assets. Following Bikker et al. [2011], additional control variables have been included to consider bank behavior and risk profile. The risk profile is composed of two variables. The ratio of customer loans to total assets ($risk_{i,t}$) holds credit and illiquidity risks. A higher proportion of loans should generate greater revenues ; hence the expected sign of risk is positive. The ratio of equity to total assets ($equity_{i,t}$) accounts for the leverage and capitalisation, reflecting differences in the risk preferences across banks. The coefficient could exhibit a negative or a positive sign. On the one hand, a lower equity ratio reflects a more risk-taking behaviour, greater leverage and therefore higher interest revenues (Molyneux et al. [1994]). On the other hand, more equity can balance more risky behaviour, suggesting a positive coefficient (Bikker and Haaf [2002a]). Other variables consider banks behavior as the ratio of customer deposits to short term funding ($deposit_{i,t}$) which captures important features of the funding mix. The ratio of other non-earning assets to total assets ($onea_{i,t}$) reflects certain characteristics to the assets composition. The sign of $onea_{it}$ is unclear. A larger share of non-interest assets is likely to reduce interest income but may raise other income.

Size is added in previous studies to take into account the economies of scale. Bikker et al. [2011] demonstrate that the introduction of size (scaled revenue equation) as the control variable biases the results [17]. The appropriate H-statistic is based on an unscaled revenue equation (without size). The scaled model is implemented to compare our results with existing literature and check the robustness. Size is measured by the natural logarithm of total assets ($size_{i,t}$). All firm-specific and time-varying factors that could affect the level of total revenues are captured through the insertion of bank-dummy (α_i) [18] and

17. The use of price (total revenue to total assets) as the dependent variable has similar distorting effect (Bikker et al. [2011]).

18. The panel can be estimated by a pooled estimator, fixed-effects estimator or random effects estimator depending on the nature of the individual effects (α_i). If there are no bank-specific effects, we can pool the observations and estimate the model using ordinary least squares. To test the pooling restriction, we use a F-test, discarding that all individual effects equal zero (results not reported). Pooling

year-dummy variables (μ_t). In all regressions, we adjust the standard errors of the regression model using the Huber-White method to ensure any remaining heteroskedasticity in the errors terms. Descriptive statistics and correlation are presented in Appendix.

A correct specification of the H-statistic value requires that the prices of the inputs (labor, deposits and physical capital) are exogenously given. Concerning labor and physical capital, banks compete with many other firms for their acquisitions ; hence, this hypothesis can be acceptable. While banks can influence the price of deposits, it is hard to imagine that deposit interest rates are fully under the banks control. The Central bank, by its intervention, constrains the market power of banks in the funds markets. A fringe of market power can exist for banks which are installed in remote areas. Insofar as the network of banks is largely concentrated in large cities we neglect the problem of deposits' price endogeneity.

Finally, as noted previously, one of the crucial hypotheses of the PR model is that the market is assumed to be in equilibrium. Thus, an equilibrium test should be performed by using an indicator of firm return as the dependent variable, with the same econometric specification (method and independent variables). The equilibrium statistic E is calculated as the sum of the elasticities of the firm return with respect to its input prices. The market is in equilibrium if E-statistic is zero [19]. To fulfill this condition, the following regression is run :

$$\begin{aligned}\log(1+ROA_{i,t}) = \beta_1 log(w^L_{i,t}) + \beta_2 log(w^F_{i,t}) + \beta_3 log(w^K_{i,t}) + \gamma_1 risk_{i,t} \\ + \gamma_2 equity_{i,t} + \gamma_3 deposit_{i,t} + \gamma_4 onea_{i,t}(+\gamma_5 size_{i,t}) + \alpha_i + \mu_t + \epsilon_{i,t} \quad (4)\end{aligned}$$

where $ROA_{i,t}$ is the pre-tax return on assets. Insofar as $ROA_{i,t}$ can be on negative values, we add a constant to avoid to drop the negative numbers. The equilibrium statistic E is

estimation is not appropriate. Following the panel date literature, we use the Hausman test to determine the appropriate estimator [Greene, 2003]. According to it, random effects estimators are biased, and we run fixed-effects estimators.

19. The profit is independent to price in the long-run equilibrium (Shaffer [1982]). However, according to Bikker et al. [2011], this equilibrium is not a perfect one. E-statistic can be negative for monopoly, oligopoly or short-run competitive equilibrium. So if $H < 0$ and $E > 0$, this would be consistent with monopoly or oligopoly. Nonetheless, if $E = 0$ long-run equilibrium characterizes the market. We will conduct equilibrium test to assess the validity of this crucial assumption.

calculated as the sum of the input price elasticities :$E = \beta_1 + \beta_2 + \beta_3$. If the E-statistic equals zero, this implies that the banking market is in long-run equilibrium.

5.3 Estimation results

The results presented in Table 4 suggest that the WAEMU banking sector is characterized by monopolistic competition for the period 2002-2007. The H-statistic lies between 0 and 1, with a value of 0.48 (0.51 for scaled equation). According to F-test results, it is possible to reject the hypothesis of perfect competition (H=1) and collusion (H=0). Although cross country comparisons results should be treated with caution [20], the degree of competition in the WAEMU appears to be limited compared with other SSA countries (see Table 2). It appears that the WAEMU banking sector is slightly less competitive than those in Ghana, Kenya, Tanzania, and Nigeria but more competitive than those in the CEMAC or Botswana. As a reminder, the previous section has shown that CEMAC banking sector is more concentrated than in the WAEMU, although Ghana and Kenya banking sectors are less concentrated. Although the lack of data does not allow to compare HHI and H-statistic results, the discernment is that there is a strong and negative relation between concentration and competition in the SSA banking sectors.

As concentration indexes analysis has shown (see previous section), 2005 is a break-year. We attempt to examine whether this break has implied a change in the competition environment. To do this, we run equations over two sub-periods : 2002-2004 and 2005-2007. The level of competition rose in the 2000s (the H-statistics value increased from 0.50 to 0.80). For the first sub-period, perfect competition and monopoly can be rejected at 1% level. Monopolistic competition characterizes market structure over the period 2002-2004. Considering the latter period, perfect competition is not always rejected (contrary to monopoly). The latest result is subject to a number of statistical caveats : (i) small number of observations are used, and (ii) the equilibrium test is rejected ($E \neq 0$).

The H-statistic calculated indicates that banks in the WAEMU region operate un-

20. The methodology and data used are not the same for each paper.

TABLE 4 – Results from PR model for WAEMU (as a whole)

	2002-2007		2002-2004		2005-2007	
	Unscaled	Scaled	Unscaled	Scaled	Unscaled	Scaled
w^L	-0.0412	-0.0433	0.114	0.0913	-0.00248	0.0171
	(-0.301)	(-0.524)	(0.909)	(0.982)	(-0.0195)	(0.208)
w^F	0.298*	0.278**	0.226*	0.252***	0.449***	0.341***
	(1.888)	(2.499)	(1.955)	(2.720)	(4.166)	(3.724)
w^K	0.223***	0.272***	0.213**	0.232***	0.396***	0.343***
	(3.038)	(4.031)	(2.373)	(3.234)	(3.106)	(3.041)
risk	1.918**	1.134*	0.990**	0.889**	1.164**	0.849**
	(2.181)	(1.817)	(2.417)	(2.059)	(2.383)	(2.249)
deposit	-0.214	-0.408	-0.396	0.0804	-1.067*	-0.574
	(-0.585)	(-1.391)	(-0.488)	(0.236)	(-1.757)	(-0.983)
equity	-0.201**	0.0363	-0.0576	0.156*	-0.119*	0.0429
	(-2.193)	(0.697)	(-0.513)	(1.829)	(-1.961)	(0.702)
onea	-0.0597	0.126*	-0.114	-0.0759	-0.113	0.0694
	(-0.724)	(1.825)	(-1.014)	(-0.838)	(-1.207)	(0.885)
size		1.044***		0.739***		1.114***
		(12.09)		(5.896)		(9.380)
constant	7.794***	-1.502	8.009***	0.852	9.220***	-2.015
	(7.858)	(-1.197)	(7.560)	(0.651)	(11.31)	(-1.420)
Obs.	484	484	220	220	264	264
Nb of Banks	110	110	84	84	102	102
R^2	0.524	0.753	0.352	0.552	0.731	0.865
H-statistic	**0.48**	**0.51**	**0.553**	**0.575**	**0.842**	**0.701**
H=0 *(F-Test)*	3.85*	9.04***	14.22***	14.63***	16.18***	15.19***
H=1 *(F-Test)*	4.53**	8.58***	9.30***	7.97***	0.57	2.77*
E=0 *(F-Test)*	0.001	0.003	0.043**	3.84*	-0.009	1.11
Hausman test	64.80***	32.24***	37.47***	35.66***	60.84***	15.76*

Note :,** and *** significant at 10%, 5%, and 1% levels, respectively. Dependent variable is the total revenue. H-statistic is the sum of the elasticites of total revenues of the firm with respect to its inputs prices. E-statistic represents equilibrium test based on Eq(4) (not reported). The table reports the results from a panel regressions using yearly data on individual banks for the period 2002-2007. All regressions are run with within estimator and year-dummies are included. t-Statistic are based on robust Huber-White sandard errors.*

TABLE 5 – Results from PR model by WAEMU members

	Benin	Burkina Faso	Ivory Coast	Mali	Niger	Senegal	Togo
Unscaled model							
H-statistic	**0.61**	**0.88**	**1.13**	**-0.24**	**1.45**	**0.49**	**0.48**
R^2	0.818	0.698	0.608	0.624	0.626	0.912	0.796
H=0 *(F-Test)*	10.31***	8.75***	6.81**	0.35	1.53	12.40***	0.81
H=1 *(F-Test)*	4.16*	0.17	0.10	9.67***	0.15	12.98***	0.95
E=0 *(F-Test)*	-0.03	0.03	0.002	-0.02	0.22	-0.03	0.06
Hausman test	36.27***	23.09***	30.86***	43.36***	23.30***	25.61***	23.22***
Scaled model							
H-statistic	**0.95**	**0.69**	**1.26**	**0.16**	**0.24**	**0.57**	**0.82**
R^2	0.898	0.837	0.718	0.905	0.769	0.952	0.888
H=0 *(F-Test)*	18.66***	10.06***	15.26***	1.07	0.07	14.02***	8.58**
H=1 *(F-Test)*	0.04	1.97	0.63	27.95***	0.72	7.99**	0.40
E=0 *(F-Test)*	-0.03	0.03	0.01	0.01	0.15	-0.03	0.08
Hausman test	29.24***	14.82	20.08*	21.33*	12.31	41.31***	22.14**
Obs.	58	78	93	76	46	86	47
Nb. of Banks	14	16	22	17	10	19	12

*Note : *,** and *** significant at 10%, 5%, and 1% levels, respectively. Dependent variable is the total revenue. The table reports H-statistic value and tests from country regressions using yearly data on individual banks for the period 2002-2007. All regressions are run with within estimator and year-dummies are included. t-Statistic are based on robust Huber-White standard errors.*

der condition of monopolistic competition ; however, a closer look at individual countries shows different patterns among them. Table 5 presents the results for each WAEMU country (Guinea-Bissau is excluded). The results should be treated with caution, insofar as the number of observations is limited in particular for Benin, Niger, and Togo (less than 70 bank-year observations and 15 financial institutions). Three different groups can be distinguish. Firstly, Ivory Coast (H-statistic value is 1.13) is the most competitive country. The banking sector in Ivory Coast is characterized by perfect competition, insofar as it is impossible to reject the hypothesis of perfect competition (H=1) contrary to the hypothesis of monopoly (H=0). Secondly, banks in Benin, Burkina-Faso, Senegal, and Togo operate under conditions of monopolistic competition. The rejection of the hypothesis of perfect competition and monopoly for Senegal confirms such a result. The conclusions regarding the three other countries is less clear-cut. Thirdly, the market structure of banks in Mali is best characterized by monopoly this is showed by a negative H-statistic value

(-0.24). Finally, we cannot draw any conclusions about the Niger case (the unscaled and scaled models give contradictory results). A possible explanation is the low number of observations. In all regressions, the equilibrium conditions have been checked and R^2 are correct.

Apart from Benin and Mali, the empirical results reveal that the market power, resulting from high concentration levels, exclude competitive behaviors (see : Table 9. The existing barriers deter the entry enable to extract rents. Although legal impediments certainly play a key role, the level of competition and concentration can be extremely different among currency union members that share a common regulatory and supervision framework in developing countries [21].

5.4 Robustness checks

Three different robustness checks have been performed. These tests consist of changing the sample (with the exclusion of non-bank financial institutions), the dependent variables (total revenues has been replaced by interest revenues), and the specification (inclusion of other control variables). Results (not reported) give no reason to alter the conclusions.

6 The conjectural variation model

6.1 Methodology

In order to assess the reliability of the previous results, we use the same dataset to perform our latest empirical test based on the conjectural variation model. It is based on the idea that a firm when choosing its output takes into account the reaction of rival firms. On the contrary, the H-statistics does not consider interactions between firms but focuses on the reaction of firms when input prices are changing. Many studies have applied conjectural variations to banking. We follow the approach and empirical specification developed by Iwata [1974] and Appelbaum [1982] which were applied by Angelini and Cetorelli [2003], and Coccorese [2005, 2009]. Using Cournot competition model [22], loans are

21. The concentration measures computed by Saab and Vacher [2007] confirms these findings.

22. A price-setting model is developed by Coccorese [2005, 2009] and a two-products model is developed by Suominen [1994]. Both models have the same econometric implications.

produced by bank i. The inverse demand at time t is given by equation $p_{it} = p_{it}(Q_t, Z_{it})$, where p_{it} is the price that bank i charges, $Q_t = \sum_{j=1}^{N} q_j$ is the industry production, and Z_{it} is a vector of exogenous factors influencing demand. In addition, let $C_{it} = C_{it}(q_{it}, w_{it})$ be the cost function for bank i, where q_{it} is the quantity that bank i produces, and w_{it} is the vector of the prices of inputs employed by the bank i. Hence, the profit maximization problem of bank-i is given as :

$$\pi_{it} = q_{it}p_{it} - C_{it}(q_{it}(\cdot), w_{it}) \tag{5}$$

The first order condition of Eq. 5 is given as :

$$\frac{\partial \pi_{it}}{\partial q_{it}} = q_{it}(\cdot)\frac{\partial p_{it}}{\partial q_{it}} + p_{it}(\cdot) - MC_{it}(\cdot) = 0 \tag{6}$$

where $MC_{it}(\cdot) = \frac{\partial C_{it}(\cdot)}{\partial q_{it}}$ represents the marginal cost function. Rearranging Eq. 6, we get :

$$p_{it} = MC_{it}(\cdot) - \frac{\theta_{it}}{\eta_{it}} = MC_{it}(\cdot) - \lambda_{it} \tag{7}$$

where $\theta_{it} = \frac{\partial Q_t/Q_t}{\partial q_{it}/q_{it}}$ is the conjectural variation elasticity and $\eta_{it} = \frac{\partial Q_t/Q_t}{\partial p_t}$ is the price semi-elasticity of demand. Eq. 7 allows to compute Lerner Index as follows : $L_{it} = \frac{\lambda_{it}}{p_i t}$.

The parameter $\theta_{i,t} (\in [0; 1])$ determines the degree of market power exercised by bank i at the time t. The full exploitation of market power, for example, monopoly or perfect collusion situation, coincides with $\theta_{i,t} = 1$. When $\theta_{it} = 0$, it conversely means that the bank is compelled to behave as a perfect competitive bank (for which the price equals the marginal costs). $\theta_{it} \in]0; 1[$ denotes an imperfect competitive situation. The specific case of the Cournot competition occurs if $\theta_{it} = \frac{1}{n}$, where n is the number of banks. The identification of the behavioral parameter for each bank (θ_{it}) is impossible to obtain. The aim is to compute the average degree of market power : $\theta = \frac{1}{NT}\sum_{i=1}^{N}\sum_{t=1}^{T}\theta_{it}$. We also compute the average degree of market power by year (θ_t) and by country (θ_j).

6.2 Data and econometric specification

To assess the behavioral parameter (θ), we estimate a three-equation system. The first equation represents the market demand function which allows to get the market demand elasticity for the price. The second one is a total function that allows to get the

marginal cost for each firm. Finally, the supply equation (Eq. 7) allows us to compute the behavioral parameter. The loan demand function is assumed to take the following form :

$$ln(q_{it}) = \alpha_0 + \alpha_1 ln(p_{it}) + \alpha_2 ln(\bar{p}_{jt-1}) + \alpha_3 foreign_{it} + \alpha_4 public_{it} + \alpha_5 size_{it} + \alpha_6 branches_{it} + \alpha_7 old_{it} + \alpha_8 risk_{it} + \alpha_9 equity_{it} + \alpha_{10} GDPpc_{jt} + \alpha_{11} popdensity_{it} + \upsilon_j + \nu_t + \tau_{it} \quad (8)$$

Subscripts i, j and t refer to bank, the country and the period respectively ; here, q_{it} and p_{it} are the quantity and the price of the output (loans) of bank i. The demand elasticity is directly given by the parameter α_1. Bank-specific control variables are included : the one-lag of the average price of all other financial institutions in the market ($\bar{p}_{jt-1}$) in order to take into account the price set by competitors [23]. We also include bank-specific variables : the share of capital owned by the State ($public_{it}$) and by foreigners ($foreign_{it}$), the size (which is measured by the natural logarithm of equity [24]), the number of branches ($branches_{it}$), the age of the bank which is a proxy of reputation (old_{it}), the ratio of customer loans to total assets ($risk_{it}$), and the ratio of equity to total assets ($equity_{it}$). Two market specific control variables are included : GDP per capita ($GDPpc_{jt}$) and the density of population ($popdensity_{jt}$). Finally, the demand equation is run with country (υ_j) and time fixed effects (ν_t) and τ_{it} is an error term.

The second equation is a total cost function. In line with the main studies on the banking industry, we consider a translog specification. Consistent with an intermediation approach, loans represent the banks' output. Regarding the inputs, three factor are considered (labor, physical capital, and deposits). The cost function assumes the following form :

$$ln(C_{it}) = \beta_0 + \beta_1 (lnq_{it}) + \frac{\beta_1}{2}(lnq_{it})^2 + \sum_{l=1}^{3} b_l (lnw_{it}^l) + \sum_{l=1}^{3} \beta_{2+l} (lnq_{it})(lnw_{it}^l) + \frac{1}{2}\sum_{l=1}^{3} b_{3+l} (lnw_{it}^l)^2 + \sum_{l \neq n} b_{6+l} (lnw_{it}^l)(lnw_{it}^n) + \sum_{k=1}^{m} z_{it}^m + \varphi_j + \psi_t + \phi_{it} \quad (9)$$

23. We refer to the national level because we do not have more disaggregated information. The inclusion of lag value allows to overcome the endogeneity issue.

24. It is a common way to measure size by the total assets (as in the previous section). However, in our case study, total assets and total loans are highly correlated ($\rho = 0.99$)

where ϕ_{it} is the error term and $z_{i,t}^{k}$ is a vector of netputs [25]. All country-specific and time-varying factors that could affect the level of total cost are captured through the insertion of country-dummy (φ_j) and year-dummy variables (ψ_t). We constrain the cost function to be homogenous of degree one in input prices, implying the following restrictions : $\sum_{l=1}^{3} b_l = 1$, $\sum_{l=1}^{3} \beta_{2+l} = 0$, and $\sum_{l=1}^{6} b_{3+l} = 0$. Measures of the output (loans) and the prices of inputs are similar to the previous section.

Finally, the third equation is based on Eq. 7 :

$$p_{it} = MC_{it}(q_{it}, w_{it}^{l}) - \lambda_t + \xi_{it} \tag{10}$$

where ξ_{it} is an error term. Computing the marginal cost from Eq. 9 and introducing it in Eq. 10, we get :

$$p_{it} = \frac{C_{it}}{q_{it}} \left[\beta_1 + \beta_2 (ln q_{it}) + \sum_{l=1}^{3} \beta_{2+l} (ln w_{it}^{l}) \right] - \lambda_t + \xi_{it} \quad \text{with} \quad \lambda_t = \frac{\theta}{\eta_t} \tag{11}$$

The system we are going to estimate is formed by Equations 8, 9, and 11. The parameter θ describes the degree of average market power exploitation in the WAEMU banking system. System equations are estimated simultaneously in order to improve the precision and efficiency of estimations [Angelini and Cetorelli, 2003, Coccorese, 2005, 2009]. Owing to the endogeneity of the cost, price, and quantity we have to use the instrumental variables estimator (2SLS). Nevertheless, owing to cross-equation contemporaneous correlations, seemingly unrelated regressions (SUR) should be used. Affected by both problems, we use the Three-Stage Least Square (3SLS), which combines 2SLS and SUR estimators (Greene [2003]) and allows to take into account cross-equations restrictions. Whilst 3SLS are convergent and efficient by correcting the variance-covariance matrix, our results should be treated with caution insofar as the sample is small (Greene [2003]). Convergence requires large sample and results are highly sensitive to specification otherwise. The same dataset to assess the conjectural variation models is used than in previous measures. Descriptive statistics and correlation are presented in Appendix.

25. The netputs include a dummy indicates if the financial institutions is a bank and the interaction between the bank-dummy and output, and interactions between the bank-dummy and the three inputs.

6.3 Results

The table 6 presents the WAEMU (entire sample) results from OLS, 2SLS, and 3SLS. We report the behavioral parameter (θ) with associated tests and the computed Lerner index (L). According to Coccorese [2009], the behavioral parameter (θ) refers to average degree of competition. As the table 6 indicates, the average market power of banks in the WAEMU is relatively high. The point estimate of θ is 0.78. It is possible to reject the hypothesis of perfect competition ($\theta = 0$) and of monopoly ($\theta = 1$) at the standard levels. The banking industry in the WAEMU is characterized by imperfect competition (as is the Ghanaian banking industry [Biekpe [2011]]). The no-competitive behavior implies a high level of Lerner index (between 50% and 70%) in the zone ; while the demand is elastic [26]. This result confirms the previous conclusions based on concentration and Panzar-Rosse measures.

Concerning the other explanatory variables, the coefficient of foreign, branches and reputation are positive and significant, as expected. The ratio of equity to total assets is negatively and significantly related to loan demand, contrary to expectations. Although the ratio of equity to total assets measures the risk profile of banks, the negative coefficient can be explained differently. Bank with a more active policy provides better quantity (more revealed demand) and a ratio of equity to total assets which is lower. According to our results, the second approach is dominant in the WAEMU banking system. Other bank-specific variables included in the demand function are not significant at the standard levels. Concerning the macroeconomic variables, while the level of GDP per capita has no significant impact, the density of population is negatively and significantly related to loan demand. The coefficients of total cost function and supply function have expected sign and are generally highly significant. The marginal cost is always positive.

The analysis of the change of banks' conduct during the period is very interesting. Particularly, we aim to verify whether there have been any modifications in their behavior after 2005, when the structure of the market changed dramatically. The results from the Panzar-Rosse model showed an increase in competition since the mid-2000's. In order

26. The estimate of the price elasticity is highly significant and around to -1. An increase to 1% in credit interest rate implies a contraction to 1% of the demand of loans.

TABLE 6 – Conjectural variation model : WAEMU results

	OLS		2SLS		3SLS	
	coef.	t-stat	coef.	t-stat	coef.	t-stat
Demand function (Dependent variable : lnq_{it})						
(lnp_{it})	-0.842***	(-9.598)	-1.025***	(-10.51)	-1.112***	(-11.42)
$ln(\bar{p}_{jt-1})$	0.0914	(0.202)	-0.0429	(-0.0942)	-0.0213	(-0.0468)
foreign	0.694***	(5.396)	0.645***	(4.966)	0.638***	(4.923)
public	0.305	(1.554)	0.190	(0.953)	0.143	(0.720)
size	-0.0629	(-1.074)	-0.0443	(-0.750)	-0.0445	(-0.755)
risk	-0.373	(-1.609)	-0.340	(-1.458)	-0.257	(-1.104)
cap	-4,435***	(-10.68)	-4,185***	(-9.931)	-4,181***	(-9.950)
branches	0.567***	(15.10)	0.556***	(14.67)	0.544***	(14.39)
old	0.293***	(5.560)	0.319***	(5.990)	0.331***	(6.227)
GDPpc	-8.25e-06	(-1.110)	-8.55e-06	(-1.144)	-8.84e-06	(-1.187)
pop density	-0.0711**	(-2.250)	-0.0711**	(-2.236)	-0.0663**	(-2.094)
constant	12.77***	(4.784)	12.14***	(4.516)	11.67***	(4.356)
R^2	0.772		0.769		0.766	
Total cost function (Dependent variable : lnC_{it})						
(lnq_{it})	0.786***	(5.382)	1.249***	(6.164)	1.172***	(5.833)
$(lnq_{it})^2$	0.0227***	(4.050)	0.0277***	(4.497)	0.0343***	(5.603)
(lnw^L_{it})	1.834***	(6.530)	2.073***	(6.167)	2.071***	(6.272)
(lnw^F_{it})	0.842***	(3.818)	0.640**	(2.190)	0.596**	(2.080)
(lnw^K_{it})	-1.677***	(-8.201)	-1.713***	(-8.023)	-1.668***	(-7.939)
$(lnw^L_{it})^2$	-0.112***	(-4.115)	-0.0225	(-0.699)	-0.0122	(-0.381)
$(lnw^F_{it})^2$	0.137***	(7.734)	0.205***	(9.370)	0.212***	(9.758)
$(lnw^K_{it})^2$	-0.0483***	(-3.424)	-0.0366**	(-2.491)	-0.0383***	(-2.634)
$(lnq_{it})(lnw^L_{it})$	-0.126***	(-5.082)	-0.221***	(-6.399)	-0.230***	(-6.735)
$(lnq_{it})(lnw^F_{it})$	0.0356*	(1.803)	0.121***	(3.954)	0.134***	(4.415)
$(lnq_{it})(lnw^K_{it})$	0.0903***	(4.766)	0.1000***	(4.992)	0.0964***	(4.876)
$(lnw^L_{it})(lnw^F_{it})$	-0.0366*	(-1.768)	-0.110***	(-4.403)	-0.119***	(-4.822)
$(lnw^L_{it})(lnw^K_{it})$	0.148***	(12.37)	0.132***	(10.33)	0.131***	(10.36)
$(lnw^F_{it})(lnw^K_{it})$	-0.100***	(-8.549)	-0.0954***	(-7.813)	-0.0931***	(-7.695)
constant	-0.937	(-0.765)	-4.067**	(-2.325)	-3.691**	(-2.144)
R^2	0.961		0.957		0.957	
Supply function (Dependent variable : p_{it})						
θ/η	0.0940***	(8.998)	0.0991***	(8.853)	0.111***	(10.02)
R^2	0.478		0.501		0.492	
θ	0.4999		0.6412		0.7774	
$\theta = 0$ (χ^2-test)	43.09***		45.83***		56.28***	
$\theta = 1$ (χ^2-test)	43.14***		14.35***		4.62**	
Lerner	0.4497		0.6254		0.6994	
Obs.	371		371		371	

Note :, **, and *** significant at 10%, 5%, and 1% levels, respectively. The table reports results from Ordinary Least Squares (OLS), Two-Stage Least Squares (2SLS), and Three-Stage Least Squares (3SLS). Year- and country-dummies are included in demand and total cost function (not reported). A vector of netputs is included in total cost function (not reported). Lagged values of prices, loans, prices of funds, size, public- and foreign ownership share, risk, and levels of capitalization are used as instruments. t-Statistics are reported in parentheses.*

to confirm these previous conclusions, the average degree of market power is computed by year. In order to cope with the lack of data, the equations system is modified by the inclusion of the interaction between year-dummy and the price in the Eq. 8 and by the inclusion of year-dummy in the Eq. 11. The cost function is unchanged. The table 7

TABLE 7 – Conjectural variation model : year results

	θ_t	$\theta_t = 0$ (χ^2-test)	$\theta_t = 1$ (χ^2-test)	$\theta_t = \theta$ (χ^2-test)
2003	0.6163	17.63***	6.83***	1.20
2004	0.8086	28.63***	1.61	0.04
2005	0.4055	7.53***	16.18***	6.33***
2006	0.6188	17.99***	6.82***	1.18
2007	0.5088	17.12***	15.95***	4.77**

The table reports the computed behavioral parameter and associated tests.

reports the behavioral parameters and associated tests by year from 3SLS estimator [27]. The estimates of θ_t take on a value between 0.40 and 0.80 and are always significant. The χ^2-tests indicate that both the hypothesis of perfect competition ($\theta_t = 0$) and the hypothesis of monopoly ($\theta_t = 1$) can be rejected for all years. Over the period, the banking system in the WAEMU remains characterized by oligopolistic competition. Contrary to the previous results from concentration ratios and PR model analysis, the 2005-break in the level of competition exists (the behavioral parameter fell from 0.80 is 2004 to 0.40 in 2005) but it seems to be temporary.

TABLE 8 – Conjectural variation model : country results

	θ_j	$\theta_j = 0$ (χ^2-test)	$\theta_j = 1$ (χ^2-test)	$\theta_j = \theta$ (χ^2-test)
Benin	1.2052	12.77***	0.37	1.61
Burkina	1.0402	39.99***	0.06	2.55
Ivory Coast	0.5562	13.77***	8.77***	2.18
Mali	0.7340	21.74***	2.86*	0.08
Niger	0.0177	0.00	13.69***	8.36***
Senegal	0.4525	7.71***	11.31***	3.98***
Togo	0.8951	9.80***	0.14	0.17

The table reports the computed behavioral parameter and associated tests.

27. Owing to lack of instruments, the first year, 2002, is excluded.

As previously, we investigate the level of competition among WAEMU members by assessing the national average degree of market power. In order to cope with the lack of data, the equations system is modified by the inclusion of the interaction between country-dummy and the price in the Eq. 8 and by the inclusion of country-dummy in the Eq. 11. The cost function is unchanged. Table 8 presents the results by country. Three groups of countries can be distinguished using the respect to behavioral parameter tests and value. The first group brings together Ivory Coast, Senegal, and Mali, which are characterized by imperfect competition. The hypothesis of perfect competition and monopoly can be rejected at 1% level of statistical significance for Ivory Coast and Senegal. For both, these outcomes corroborate results from concentration ratios analysis and from the Panzar and Rosse model for Senegal. The hypothesis of monopoly can be rejected at only 10% level of statistical significance for Mali. This result does not confirm the previous results that characterize the financial market in Mali as a monopolistic one. The second group is composed by Benin, Burkina-Faso and Togo. Contrary to previous analysis, it is not possible to reject the hypothesis of monopoly for the three banking systems. The third group is composed of Niger. Albeit the behavioral parameter indicates a situation of perfect competition in Niger, this result is subject to caution (coefficients may be biased owing to the lack of data and previous analysis has highlighted the low level of competition in the Niger banking sector). Finally, apart from Niger and Senegal, the national level of market power is statistically equal to the average level of market power. The level of competition seems to be equal in each member's country. This last result is inconsistent with previous conclusions that have revealed the lack of convergence in competition levels.

6.4 Robustness checks

In order to test the robustness of our results, different specifications have been implemented. Firstly, we run the model by OLS and 2SLS. As mentioned previously, convergence is not always achieved insofar as the sample is relatively small. 2SLS and 3SLS should be given similar coefficients because both are convergent, albeit 3SLS estimator is more efficient. As the Table 6 shows, these specifications give different results (the behavioral parameter is higher in 3SLS). Moreover, the inclusion or exclusion of one (or

more) variable(s) may change dramatically the results and conclusions. For instance, the introduction of dummy for non-bank institutions in demand function modifies dramatically the results [28]. Hence, the results from the conjectural variation model are highly sensitive to specification. Consequently, results from the conjectural variation model must be treated with caution ; insofar as we are not certain that the equations are correctly specified. To conclude, we have more confident in the Panzar-Rosse model results which have successfully passed many robustness checks.

7 Conclusion

This paper examines competitive structures in WAEMU banking sector over the period 2002-2007. Concentration market analysis and two NEIO techniques (Panzar-Rosse model and conjectural variation model) are applied to a sample of 110 financial intermediaries in the WAEMU. To our knowledge, no econometric analysis of the degree of competitiveness in WAEMU banking sector has been conducted before.

The main results are as follows : Firstly, although competition was fierce during the mid-2000s, the level of competition remains limited in WAEMU. The level of competition is one of the lowest in the world. In SSA, only the CEMAC and Botswana banking sectors are more collusive and concentrated.

Secondly, apart from Benin and Mali, structural and non-structural approaches are closely related contrary to previous findings (cf. Table 9). Hence concentration is a good proxy to a competitive environment for LIC.

Thirdly, even if the regulatory and supervision framework is the same, the level of competition differs among WAEMU members. These results can be explained by two ways : on the one hand, the implementation and law enforcement differ from country to country. Nonetheless, although no figures are available, the assumption that law enforcement does not significantly differ is acceptable. On the other hand, the most plausible explanation is the fact that legal barriers are not so much crucial to the explanation of bank competition in SSA and LIC. Recently, Delis [2012] has shown that financial libera-

28. While the WAEMU as a whole remains characterized as an imperfect competition market, it is impossible to observe any difference between year and country.

TABLE 9 – Summary of results

	Concentration (HHI)		
H-stats	Low ($HHI < 1000$)	Moderate ($1000 \leq HHI < 1800$)	High ($HHI \leq 1800$)
Perfect competition	Ivory Coast		
Monopolistic competition		WAEMU ; Burkina-Faso Senegal ; Togo	Benin
Collusion		Mali	
Unclassified			Guinea-Bissau ; Niger

The first diagonal reflects the convergence of results.

lization policies increased competition in developed countries with advanced institutions. In contrast, such policies have not been efficient in countries with weaker institutions. What is more, concentration has a significant and positive impact on market power in Low-Income Countries. Our results confirm his conclusions. Non-legal barriers account for a large part of bank competition [29] that explain the relevance of concentration measures as competition proxies.

Concerning the policy implications, this result highlights that financial liberalization is not sufficient to promote bank competition in LIC. The bank competition policy should not only be concentrated on legal impediments but also on non-legal ones. One major non-legal barrier is the difficulty to obtain information by banks. Information can be viewed as a sunk cost. In this way, the most effective policy in LIC should be to facilitate the access of borrowers information by banks. In practice, two policies can be implemented : the first one is to ease the production of information by firms, banks, and fiscal administration. The second one is to facilitate the sharing of information. A first step in this way has been developed by the Central Bank and other partners. For instance, since the mid-1990s the accounting frameworks have been standardized and a credit bureau have been set up. In addition, reforms to corporate legal framework give a better protection, so that investors can foster the level of competition in banking sector. These reforms, among others, should spur the bank sector competition and the financial development.

29. Moreover, demand-side factors may play a significant role and as far as we know, no analysis has examined this issue.

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Appendix

FIGURE 2 – Bank branch density in WAEMU and Selected African Countries

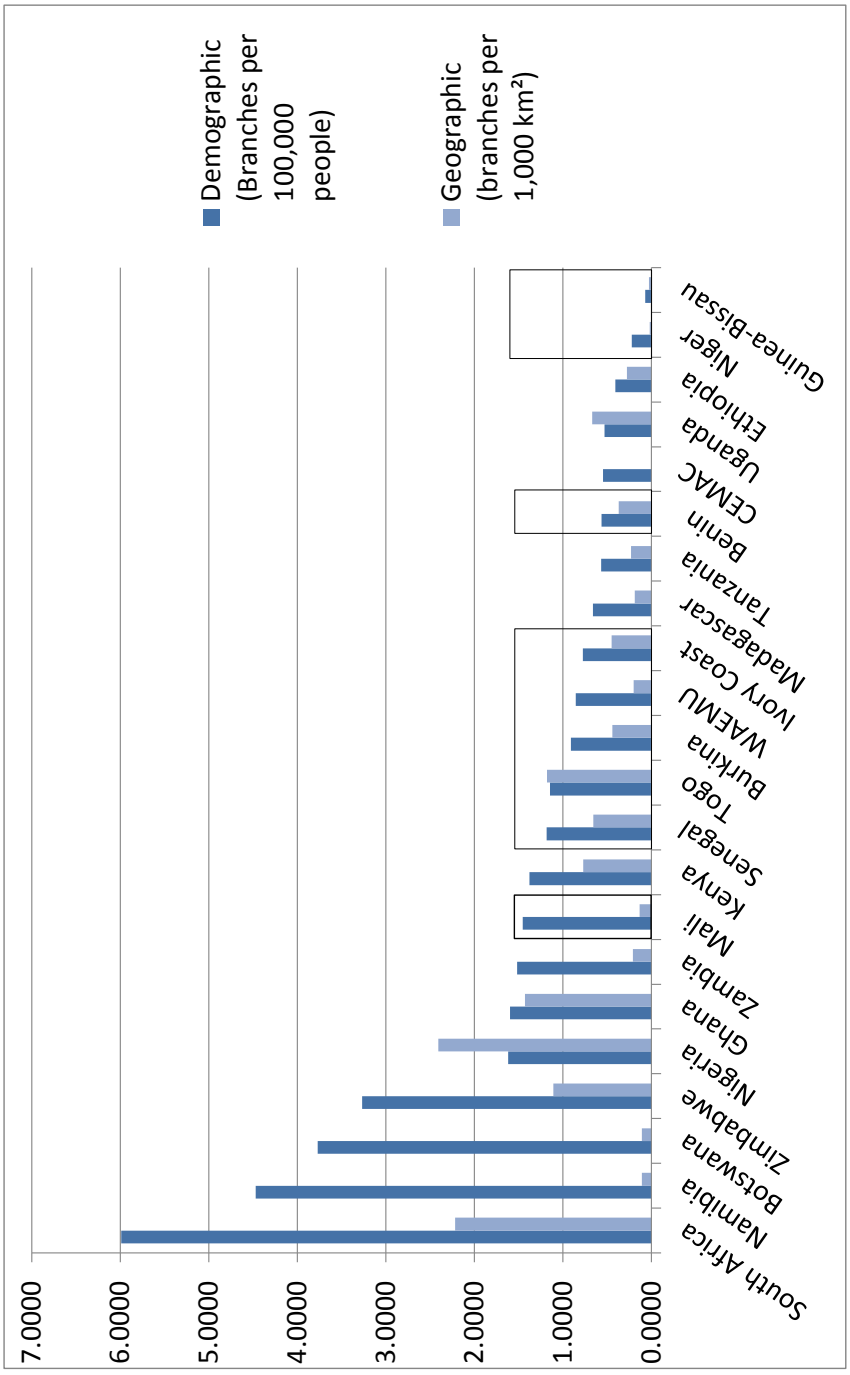


FIGURE 3 – Allocation of loans by sectors

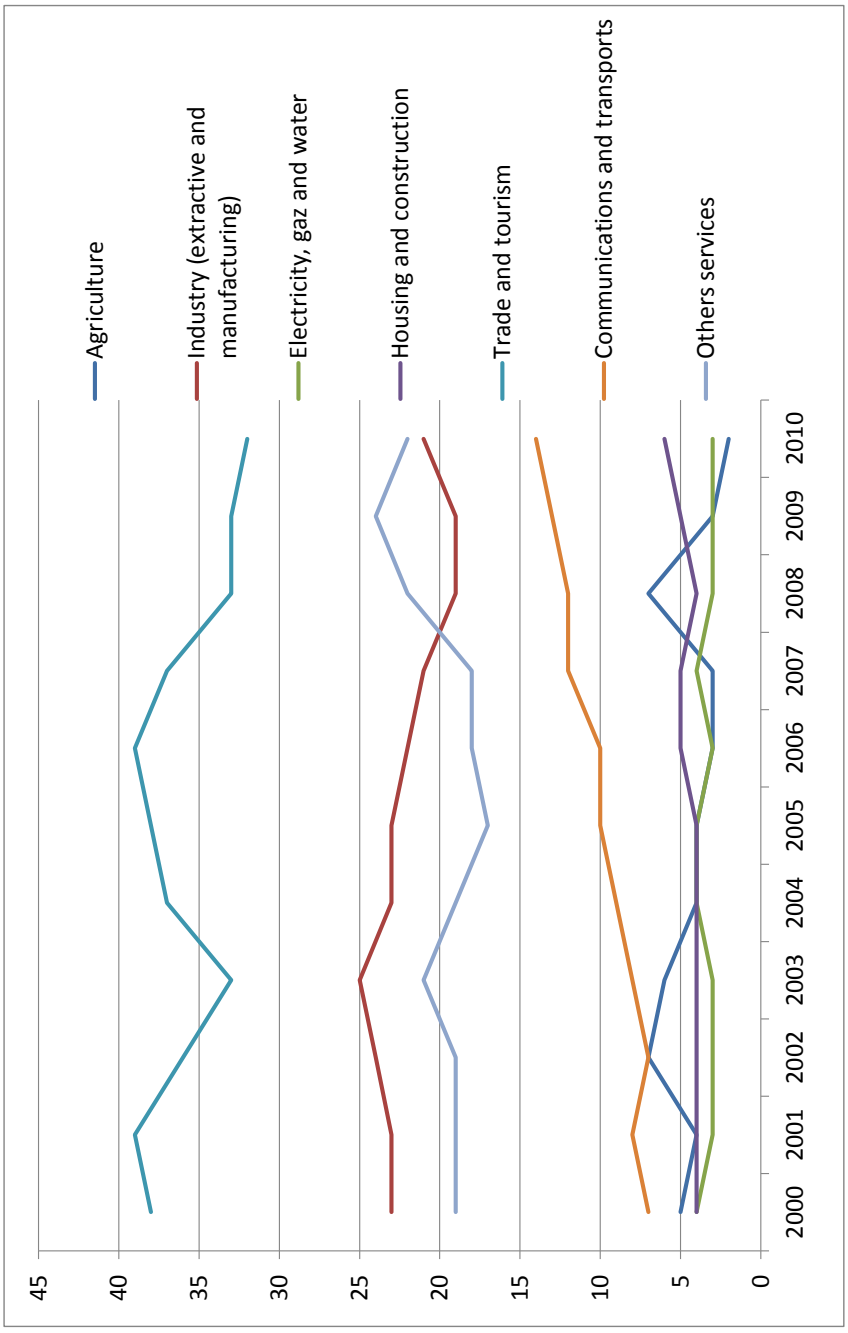


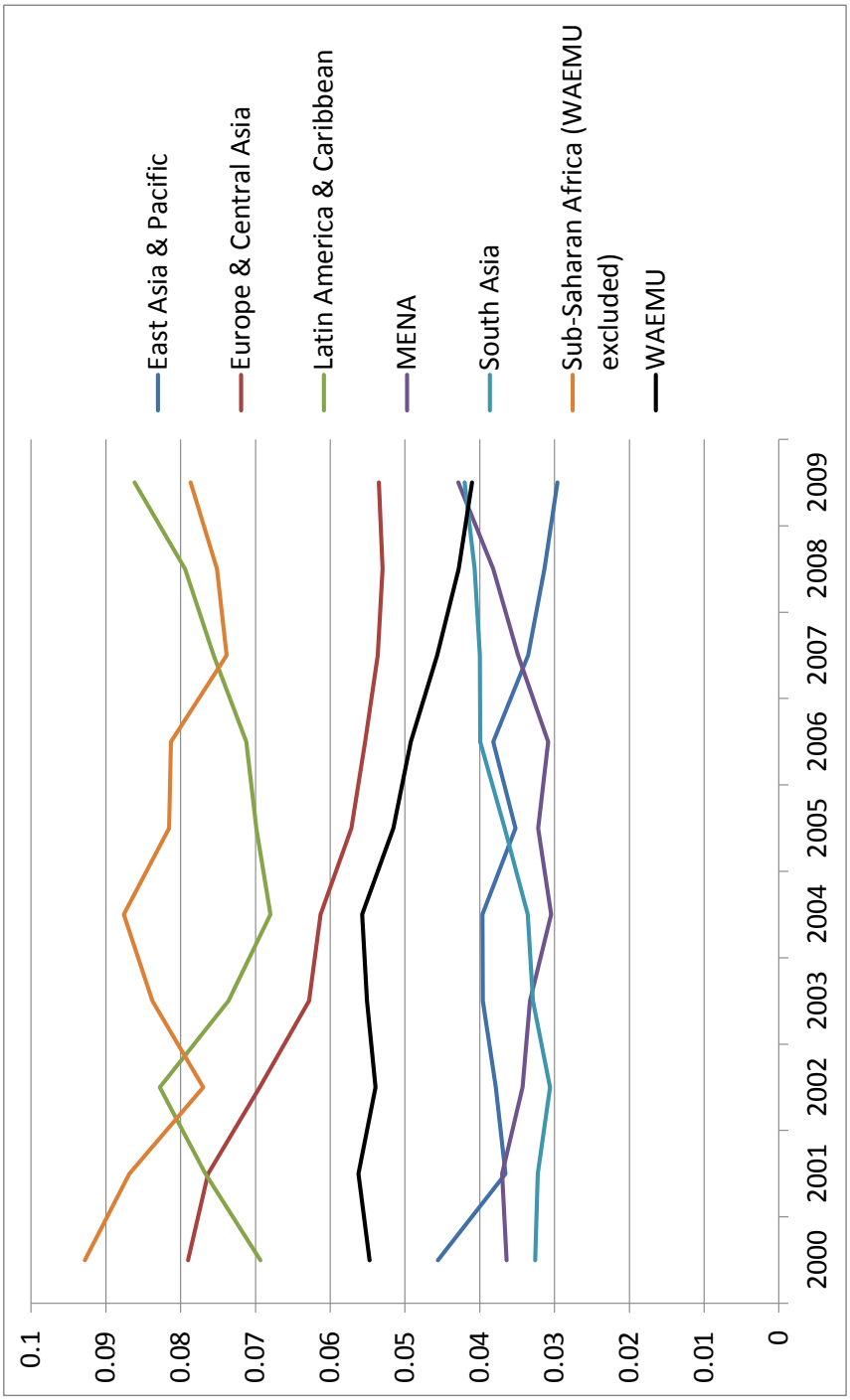
TABLE 10 – Selected financial indicators by country

	Benin			Burkina-Faso			Ivory Coast			Bissau Guinea		
	2000	2005	2010	2000	2005	2010	2000	2005	2010	2000	2005	2010
Total assets (in bn. FCFA)	477132	723204	1630140	448766	738188	1604727	1991144	2025926	3683360	42368	23319	102319
Number of FI[a] (banks)	8 (7)	14 (12)	13 (13)	12 (7)	16 (11)	17 (12)	22 (16)	19 (17)	21 (20)	3 (3)	2 (2)	4 (4)
Employees	590	1107	1998	1871	1782	2337	4775	3339	5835	126	75	204
bank branches	34	51	158	118	108	188	150	157	499	6	2	17
Loans maturity (% of total loans)												
- *Short term (< 1 year)*	64.89	68.58	71.31	72.93	64.59	61.88	62.03	76.64	66.49	98.42	94.00	49.63
- *Medium term*	34.41	27.80	26.79	25.20	33.31	35.65	31.82	19.49	29.17	1.58	6.00	50.34
- *Long term (> 5 years)*	0.70	3.62	1.89	1.88	2.10	2.47	6.16	3.87	4.34	0.00	0.00	0.03
Profitability and efficiency												
- *Return on Equity*	1.9	-2.0	9.9	1.8	10.8	20.1	7.0	10.6	0.3	-13.8	11.4	6.2
- *Spread*	4.7	5.7	6.7	7.8	8.2	7.0	7.2	7.7	7.8	8.8	6.0	9.4
Asset quality												
- *NPLs[b] to total loans*	14.4	16.0	15.7	12.0	13.4	17.7	19.1	29.1	16.2	81.6	12.8	9.9
- *Provisions over NPLs*	54.1	46.5	65.1	70.7	64.9	52.7	71.4	53.3	77.4	20.1	95.6	42.2

	Mali			Niger			Senegal			Togo		
	2000	2005	2010	2000	2005	2010	2000	2005	2010	2000	2005	2010
Total assets (in bn. FCFA)	541411	927570	1853423	142780	236535	717310	1019561	1760734	2408344	236950	417990	857772
Number of FI[a] (banks)	12 (11)	15 (11)	15 (13)	8 (7)	10 (9)	11 (10)	14 (10)	16 (12)	19 (18)	11 (7)	10 (7)	13 (11)
Employees	1108	1612	2711	505	687	1073	1573	2195	3980	1120	1172	1683
bank branches	152	176	291	19	36	78	74	167	305	96	71	157
Loans maturity (% of total loans)												
- *Short term (< 1 year)*	81.93	77.30	63.49	83.65	68.85	53.13	63.59	61.51	51.14	53.33	69.62	57.90
- *Medium term*	16.80	18.37	31.70	12.75	28.57	43.69	31.06	34.13	43.04	43.92	28.75	39.64
- *Long term (> 5 years)*	1.28	4.33	4.81	3.60	2.58	3.18	5.35	4.36	5.82	2.76	1.63	2.45
Profitability and efficiency												
- *Return on Equity*	-1.5	8.7	13.1	-1.9	9.2	20.9	16.2	12.7	12.4	-19.4	7.2	8.6
- *Spread*	5.8	6.5	7.5	8.0	9.1	8.6	6.1	7.2	6.6	7.6	7.7	7.1
Asset quality												
- *NPLs[b] to total loans*	25.1	27.8	22.2	24.0	20.7	15.7	13.1	11.8	17.6	34.3	31.3	13.6
- *Provisions over NPLs*	50.0	51.4	67.2	80.4	68.5	51.8	67.6	73.2	53.8	69.1	50.0	72.0

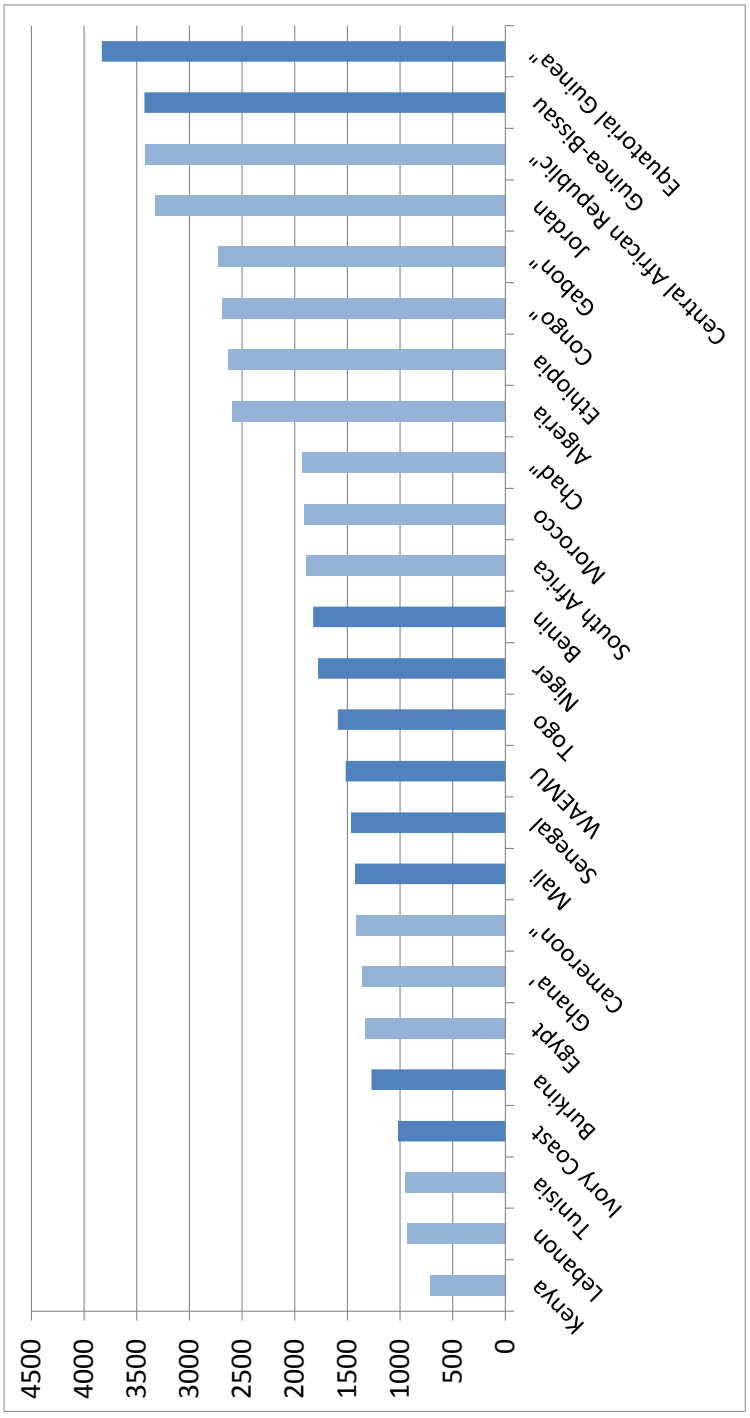
Source : COBAC annual reports, Author's calculations. [a] FI : Financial institutions ; [b] NPL : Non-performing loans.

FIGURE 4 – Net interest margins by group (developing countries)



Source: Financial structure database (Beck and al., 2010); Author's calculations

FIGURE 5 – HHI in selected MENA and SSA countries, 2007



Source: Saab and Vacher (2007), Buchs and Mathisen (2005), Demirgüç-Kunt and Martinez-Peria (2010), COBAC (2007), Rajhi and Salah (2011), South African Reserve Bank (2007), National Bank of Ethiopia (2007), and Central Bank of Kenya (2007); Author calculations. ' and " indicate data for 2003 and 2005 respectively.

TABLE 11 – Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Dependent variables					
Total assets	499	69254.54	82275.73	456.3871	435232.2
Loans	497	54675.69	64278.05	187.8134	359890.3
Revenues	499	6972.073	8370.472	24.17682	49871.87
Return on Assets	499	0.0016944	0.0554618	-0.3206806	0.3999336
Total cost	497	5032.837	5575.653	25.93613	32580.86
Prices					
price of output	497	0.1566019	0.1171525	0.0187155	0.7323285
wage	492	9.861947	5.709095	2.423851	55.68582
price of deposits	486	0.032338	0.0902667	0.0004535	1.941176
price of capital	493	3.019054	8.70962	0.1406422	92.33334
Other variables					
risk	499	0.5692095	0.1899644	0.0006264	0.9617373
deposits	489	0.7727931	0.2827715	0	1
equity	499	0.1631248	0.1678675	0.0084337	0.9943
onea	499	0.0883698	0.0595969	0.0072452	0.5534102
equity to total assets	497	0.0000493	0.0002233	1.73E-07	0.0036599
$\bar{p}_{jt-1}$	497	0.1281046	0.0160394	0.0808109	0.2004317
foreign share	494	0.5616511	0.3509897	0	1
public share	494	0.1474447	0.2281085	0	1
branches	494	8.809717	12.1737	1	90
old	497	16.96378	13.17403	0	51
GDPpc	497	202457.8	120570.8	51737.94	371020.2
pop density	497	52.05007	29.5843	8.692682	115.8392

TABLE 12 – Correlations : Demand function

	$ln(q_{it})$	$ln(p_{it})$	$ln(\bar{p}_{jt-1})$	foreign	public	risk	size	cap	branches	reputation	pop density	GDPpc
$ln(q_{it})$	1											
$ln(p_{it})$	-0.1893*	1										
$ln(\bar{p}_{jt-1})$	0.1163*	0.0294	1									
foreign	0.0777	-0.1255*	-0.0062	1								
public	0.0787	-0.1068*	0.0272	-0.5547*	1							
risk	0.3079*	0.2111*	0.1026*	0.0099	-0.0605	1						
size	-0.5496*	0.0571	-0.0323	-0.0968*	0.0201	-0.4593*	1					
cap	-0.5058*	0.0421	-0.0785	-0.1288*	0.031	-0.3289*	0.4703*	1				
branches	0.6268*	0.0608	0.0549	-0.2019*	0.2398*	0.2490*	-0.3119*	-0.1960*	1			
old	0.4244*	0.2223*	0.1609*	-0.1958*	0.3030*	0.2033*	-0.1739*	-0.1797*	0.5223*	1		
pop density	0.1079*	-0.0031	0.3793*	0.0243	-0.0093	-0.0805	-0.0793	-0.1125*	0.0781	0.1414*	1	
GDPpc	0.2781*	0.0352	0.2979*	0.0628	-0.1886*	0.2145*	-0.074	-0.0625	0.0802	0.0772	0.0981*	1

TABLE 13 – Cost function : Correlations

	$ln(C_{it})$	(lnq_{it})	$(lnq_{it})^2$	(lnw^L_{it})	(lnw^F_{it})	(lnw^K_{it})	$(lnw^L_{it})^2$	$(lnw^F_{it})^2$	$(lnw^K_{it})^2$	$(lnq_{it})(lnw^L_{it})$
$ln(C_{it})$	1									
(lnq_{it})	0.9551*	1								
$(lnq_{it})^2$	0.9542*	0.9960*	1							
(lnw^L_{it})	0.3845*	0.3708*	0.3685*	1						
(lnw^F_{it})	-0.1742*	-0.2178*	-0.2021*	-0.0065	1					
(lnw^K_{it})	-0.2304*	-0.2575*	-0.2473*	0.2369*	0.4106*	1				
$(lnw^L_{it})^2$	0.3284*	0.3156*	0.3135*	0.9832*	0.0047	0.2522*	1			
$(lnw^F_{it})^2$	0.0576	0.0911*	0.0819	-0.0297	-0.9663*	-0.3621*	-0.0346	1		
$(lnw^K_{it})^2$	-0.3951*	-0.3953*	-0.3833*	0.0135	0.3698*	0.7089*	0.0334	-0.3150*	1	
$(lnq_{it})(lnw^L_{it})$	0.7497*	0.7620*	0.7613*	0.8762*	-0.1025*	0.0417	0.8474*	0.0176	-0.1817*	1
$(lnq_{it})(lnw^F_{it})$	-0.6816*	-0.7333*	-0.7238*	-0.2123*	0.8141*	0.4823*	-0.1745*	-0.7229*	0.5045*	-0.5160*
$(lnq_{it})(lnw^K_{it})$	-0.1979*	-0.2196*	-0.2106*	0.2841*	0.3547*	0.9845*	0.3051*	-0.3133*	0.6389*	0.0998*
$(lnw^L_{it})(lnw^F_{it})$	-0.4036*	-0.3959*	-0.3867*	-0.7279*	0.6712*	0.1202*	-0.7126*	-0.6141*	0.2296*	-0.7151*
$(lnw^L_{it})(lnw^K_{it})$	-0.2292*	-0.2308*	-0.2214*	0.3211*	0.3404*	0.9688*	0.3488*	-0.3025*	0.7014*	0.1138*
$(lnw^F_{it})(lnw^K_{it})$	0.2368*	0.2639*	0.2436*	-0.2384*	-0.3526*	-0.9664*	-0.2602*	0.3380*	-0.6426*	-0.0556

	$(lnq_{it})(lnw^F_{it})$	$(lnq_{it})(lnw^K_{it})$	$(lnw^L_{it})(lnw^F_{it})$	$(lnw^L_{it})(lnw^K_{it})$	$(lnw^F_{it})(lnw^K_{it})$
$(lnq_{it})(lnw^F_{it})$	1				
$(lnq_{it})(lnw^K_{it})$	0.4106*	1			
$(lnw^L_{it})(lnw^F_{it})$	0.7041*	0.0427	1		
$(lnw^L_{it})(lnw^K_{it})$	0.4030*	0.9749*	0.0298	1	
$(lnw^F_{it})(lnw^K_{it})$	-0.3831*	-0.9724*	-0.0395	-0.9492*	1