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Credit risk and bank competition in Sub-Saharan Africa

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ABSTRACT

This paper investigates the relationship between bank competition and stability in Sub-Saharan Africa. Using financial statements on 221 banks from 33 countries over the period 2000–15, we provide evidence for a U-shaped relationship between bank competition and credit risk. Up to a certain threshold, higher levels of bank competition are associated with lower credit risk. Above this threshold, more competition increases credit risks as the positive effects of competition are outweighed by the adverse effects of rising competition. The optimal threshold appears to be higher for African banks compared to banks from developed countries. We also find that credit risk in Sub-Saharan Africa is not only related to macroeconomic determinants, such as growth, public debt, economic concentration and financial development, but also to the business and regulatory environment. In particular, bank risks appear to be lower in countries where credit registry coverage is higher and the tenure of supervisors is shorter.

1. Introduction

The purpose of this study is to determine how competition among banks affects credit risk in Sub-Saharan Africa (SSA). Banking sectors in Sub-Saharan Africa have been growing rapidly during the last two decades in part due to liberalization policies in the 1990s, the boom in commodity prices and high growth in the region (Gakunu, 2007; Mlachila et al., 2013; Otchere et al., 2017). These changes have led to a rise in the number of banks (from 445 in 2005 to 560 in 2015) in the form of both local banks and Pan-African bank conglomerates (IMF, 2015). Concerns about financial stability have grown accordingly reinforced by local shocks, such as the Nigerian banking crisis of 2009–10, and external pressure including the threat of de-risking by global banks, increased protectionism and tightening global financial conditions (FSB, 2017; IMF, 2019). With credit risk being high for international standards, on the raise since the drop in commodity prices and the ensuing African economic slowdown in 2014 (Fig. 1), analyzing the determinants of credit risk, seems both relevant and timely. Even more, since the development of banking sectors in SSA has long been constrained by the importance of credit risk, the region has the lowest level of financial access and depth as compared to the rest of world (Table 1).

Banking sector competition is generally seen as a crucial driver of investment and economic growth. It ensures the efficient allocation of resources and capital, and prevents situations in which the market dominance of a few large banks drives up the cost of credit and limits the access to credit for small entrepreneurs and the poorer parts of the society. This is particularly relevant in SSA where financial markets are underdeveloped and few funding alternatives exist outside the banking system. Despite its potential benefits, however, tighter competition can also have negative side effects in the form of excessive competition by market entrants and reduced profit margins. This can in turn increase risk-taking incentives of incumbent banks.

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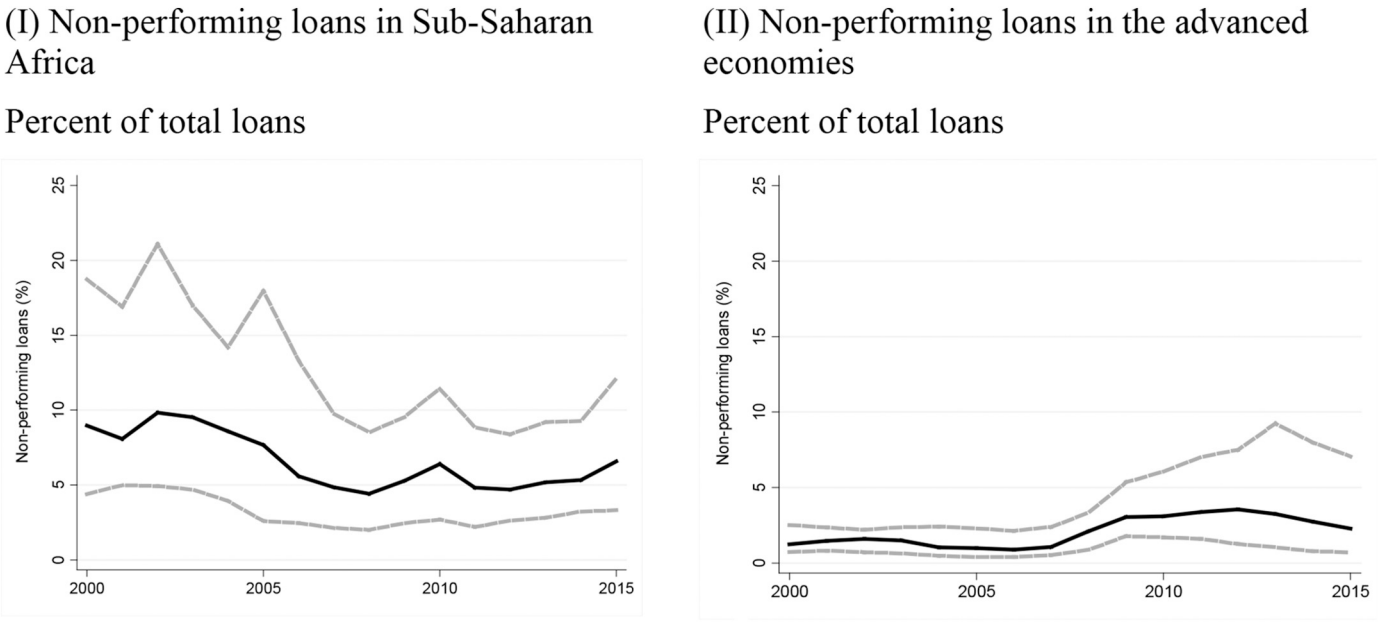

Fig. 1. Credit risks in Sub-Saharan Africa and the advanced economies, 2000–2015.
Note: The figure provides information on the non-performing loan ratio defined as impaired loans to total loans. It shows the 25th, 50th (median) and 75th percentiles of the distribution of non-performing loans. The figure reported for the advanced economies is based on a sample of 105 major banks from the G10 countries plus Austria, Australia, and Spain (Brei and Gambacorta, 2016). All values are unweighted averages across banks and countries.
Sources: Fitch Connect and authors' own calculations.

Table 1
Main features of banking sectors across regions, 2000–2015.

Country	No. countries	CR3	CR5	NPL	NIM	ROA	Liquid assets	Capital ratio	Bank accounts	Credit to private
		% of assets	% of assets	% of loans	% of earning assets	% of assets	% of deposits and ST funding	% of assets	per 1000 adults	% of GDP
Sub-Saharan Africa	48	**80.6**	**91.3**	**7.2**	**6.5**	**2.0**	**38.1**	**10.3**	**109**	**12.7**
Middle East & N. Africa	21	75.5	**91.4**	7.1	3.0	1.2	34.3	8.8	642	42.5
Advanced Europe	22	**79.9**	89.3	2.5	1.3	0.4	**35.8**	5.7	1110	99.3
Emerging Europe	34	64.5	77.9	5.8	4.3	1.2	34.0	**11.5**	946	34.7
North America	2	44.4	57.9	1.2	3.1	0.9	19.0	7.1		55.2
South America	11	52.3	71.9	3.1	**6.0**	1.5	31.4	10.1	586	**24.1**
Central Am. & Carib.	28	78.9	87.3	3.0	5.2	**1.6**	27.0	10.1	713	46.4
South-East Asia	36	66.0	77.3	2.7	3.2	1.1	27.9	8.9	452	41.4
Central Asia	8	59.5	77.4	**8.5**	4.0	1.1	23.4	7.2	**310**	27.9
Total*/Average	**210***	**66.9**	**80.2**	**4.6**	**4.1**	**1.2**	**30.1**	**8.8**	**609**	**42.7**

Note: The numbers are median values across countries over the period 2000–2015. “CR3 (5)” is the concentration ratio of the top 3 (5) banks, “NPL” are non-performing loans, “NIM” the net interest margin and “ROA” the return on assets.
Sources: Global Financial Development Database and author's own calculations.
Bold numbers indicate two regions in which the indicators are highest (lowest in the case of bank accounts).

Our study contributes to the existing literature in three major ways: (i) its focus on Sub-Saharan Africa, a region where few empirical studies using similar disaggregated banking data have been conducted; (ii) the empirical establishment of a dynamic U-shaped relationship between bank competition and credit risk, suggesting a possible path to reconcile current opposing views on this topic; and (iii) its emphasis on regulatory and policy factors.

Why is our first contribution, the focus on rapidly growing Sub-Saharan African banking systems of particular interest for both economic analysis and policy-making? Because a growing strand of theoretical and empirical research highlights the importance of financial deepening and inclusion to support economic growth in Sub-Saharan African countries (Chauvet and Jacolin, 2017; Leon, 2015; Ncube, 2007). In such countries characterized by high levels of economic growth and low levels of financial market development, reliance on banking sectors to ensure adequate and smooth financing is paramount. Even if banking systems remain relatively weak and isolated in SSA (Marchettini and Maino, 2015), banking crises arising from rapid financial development and credit booms are an increasing source of concern for regulatory and supervisory authorities. This is so because the interactions between credit and economic cycles have become stronger, similar to the trends observed in the advanced economies (Mlachila et al., 2013).

In this context, disentangling possibly conflicting effects of bank competition on credit risk becomes an issue of increasing importance in SSA. Bank competition might arguably spur efficiency gains (through, for example, lower credit costs, improved operational and risk management practices, or better allocation of capital), and it thus might contribute to higher potential growth and translate into sounder credit portfolios. However, it might also encourage additional risk taking by financial intermediaries, making banks more fragile in the face of economic fluctuations and deterioration in the quality of credit books.[1] Shedding light on the bank competition and credit risk nexus, a large body of theoretical and empirical literature produced mixed conclusions (Keeley, 1990; Salas and Saurina, 2003; Boyd and De Nicolo, 2005;; Martinez-Miera and Repullo, 2010; Fungáčová and Weill, 2013; Jiménez et al., 2013; Beck et al., 2013a).

The second and main contribution of our research is to show that bank competition and credit risk in SSA follow a dynamic U-shaped relationship. Based on a sample of 221 banks from 33 countries in SSA over the period 2000–15, we find that higher competition is associated with lower credit risks, but once a certain threshold is reached, this relationship is reversed. We also find that the relationship differs across banks from Africa and banks from developed countries. Our findings complement and extend the results obtained by Turk Ariss (2010) on developing countries from different regions, and the studies of Kouki and Al-Nasser (2017), Akande et al. (2018) and Sarpong-Kumankoma et al. (2018) on Sub-Saharan Africa. According to our results, increased competition can contribute to reducing credit risk in 7 countries with low levels of competition, whereas the optimal level of competition has been outreached in the remaining 26 countries.[2]

The third contribution of our study is to show that credit risk is not only a reflection of macroeconomic (growth, diversification)

[1] As Brock and Suarez (2000) argue in the case of the Latin American experience, regulators overly permissive attitude towards the entry of new banks can pose a threat to financial system stability, especially, when many or large entrants compete aggressively with the existing banks for costumers by lowering loan rates and increasing deposit rates to levels that are unsustainable.

[2] According to our results, banks from Swaziland, Madagascar, Central African Republic, Chad, Equatorial Guinea, Sierra Leone, and Ethiopia recorded on average a higher market power than the optimal threshold. For these countries, enhanced bank competition would be associated with lower credit risks up to the optimal level. One has, however, take into consideration the important foreign bank presence in most of these banking sectors and that the optimal level of competition differs across banks from Africa and banks from developed countries, for which the optimal threshold is lower (0.38 compared to 0.57). In the seven countries, increasing competition would thus be beneficial in terms of bank stability. For the remaining 26 countries, the average level of competition has been higher compared to the optimal threshold.

and financial (financial deepening, composition of bank portfolios) factors, but also of institutional and regulatory factors. More specifically, we find that credit risks have been lower in countries where there operate more branches, credit registry coverage is higher, and the tenure of supervisors is shorter. Finally, this study contributes to the literature on financial stability in Sub-Saharan countries by pinpointing the adverse impact of public indebtedness on bank credit risk, where government and public enterprises make up a significant portion of the formal economy (IMF, 2019). This highlights the existence of a macro-financial spillover mechanism from sovereigns to banks, a growing matter of concern and public policy debate, among central banks, bank regulators and supervisors (IMF, 2018).

The remainder of the paper proceeds as follows. Section 2 provides an extensive review of the related literature. Section 3 discusses and reports summary statistics for the sample data. Section 4 describes the empirical model and discusses the definitions of the variables selected in parameterizing the empirical model. The empirical results are reported in Section 5, and Section 6 discusses the robustness checks. The final section concludes.

2. Literature review on bank competition and stability: competition-fragility versus competition-stability view

The theoretical literature provides conflicting predictions on the relationship between competition and stability (Beck, 2008). One strand of the literature suggests that less competitive banking systems are associated with lower credit risk and more stability (competition-fragility view). A central argument is that higher oligopoly rents provide banks a cushion against unexpected shocks and reduce incentives for risk-taking (Marcus, 1984; Keeley, 1990). In systems with limited competition, banks tend to have better profit opportunities, higher franchise values and capital cushions, and thus fewer incentives to take on risks. Other arguments in favour of this view are based on differences in informational rent extraction (Boot and Thakor, 1993), interbank market competition (Allen and Gale, 2000), deposit market competition (Hellmann et al., 2000), economies of scale (Diamond, 1984), and banking supervision (Allen and Gale, 2000).

In contrast, other theoretical models predict that more competitive banking systems are more stable (competition-stability view). Boyd and de Nicolo (2005), who introduce in their model loan market competition, argue that higher loan rates in more concentrated systems induce bank borrowers to assume greater risk which results in increased loan defaults. This effect can be amplified if lower competition is associated with credit rationing, adverse selection and larger loans (Stiglitz and Weiss, 1981; Caminal and Matutes, 2002). Other models suggest that less competitive environments with larger banks are distorted by implicit government guarantees (Mishkin, 1999; Cerasi and Daltung, 2000; Farhi and Tirole, 2012) and subject to higher systemic risk (Kroszner, 2010).

Martinez-Miera and Repullo (2010) extend the model of Boyd and de Nicolo (2005) and introduce imperfect correlation of loan defaults. Their model implies a U-shaped relationship between bank competition and bank failure: at the beginning, more competition leads to more stability but after a certain threshold it can lead to more fragility. The authors highlight two opposing effects of competition: (i) it leads to lower loan rates, lower borrower default probabilities, and thus sounder loan books (risk-shifting effect), and (ii) lower interest revenues from performing loans erode bank cushions (margin effect) and have an adverse effect on bank stability. The model implies that beyond a certain threshold of competition the risk-shifting effect is always dominated by the margin effect, so competition leads to more fragility by eroding interest revenues. Below this threshold with less competition the effect is ambiguous but numerical simulations suggest that the risk-shifting effect dominates and that competition leads to more stability by improving borrowers' repayment capacity.

The competition-stability relationship will also depend on other factors including the financial structure of banks (Freixas and Ma, 2014), regulatory environment (Hellmann et al., 2000), deposit insurance (Diamond and Dybvig, 1983), and market structure (Beck, 2008).

A large body of empirical studies has produced ambiguous results (see Zigraiova and Havranek (2016) for a meta-analysis). In favour of the competition-fragility view are the results reported by Dick (2006) for the United States, Levy-Yeyati and Micco (2007) for Latin America, Jiménez et al. (2013) for Spain, Agoraki et al. (2011) for Central and Eastern Europe, Kouki and Al-Nasser (2017) and Akande et al. (2018) for SSA, and Soedarmono and Tarazi (2016) for Asia-Pacific. Beck et al. (2013a) find that that competition enhances bank fragility in countries with stricter activity restrictions and more generous deposit insurance systems, whereas stock market development and credit information sharing systems have a positive impact on stability. Studies supporting the competition-stability view include Jayaratne and Strahan (1998) and Goetz (2018) on the United States, Salas and Saurina (2003) on Spain, Schaeck and Cihák (2014) on the United States and Europe, Craig and Dinger (2013) on Central and Eastern Europe, Kasman and Kasman (2015) on Turkey, Fu et al. (2014) on Asia-Pacific, and Beck et al. (2006) for developed and developing countries. IJtsma et al. (2017) do not find any economically significant effect of competition on stability for the European Union.

A number of empirical studies have tested for the presence of a U-shaped relationship between competition and stability. In Turk Ariss (2010), the non-linear term is statistically not significant for a sample of 821 banks from 60 developing countries (of which 14 from Africa) over the period 1999–2005. In Berger et al. (2009) and Beck et al. (2013a), it is significant only for a small fraction of countries. While Liu et al. (2013) and González et al. (2017) confirm Martinez-Miera and Repullo (2010)'s hypothesis of a U-shaped relationship for European and Middle East and North African (MENA) countries, respectively, Tabak et al. (2012) find evidence of an inverted U-shaped relationship in Latin America. Cuestas et al., 2020 also highlight a non-linear relationship between financial stability and banking competition in the Baltic countries.

A number of studies have examined the competition-stability nexus on the bank-level in Sub-Saharan Africa. An empirical study that focuses on a large sample of banks from SSA is that of Kouki and Al-Nasser (2017), but the authors obtain conflicting results when using cross-sectional regressions. We believe that our dynamic panel setting, such as that of Akande et al. (2018) on 440 banks from 37 SSA countries, is better suited to study the competition-risk relationship within banks by taking into account unobserved

bank-fixed effects and by using the system GMM estimator to reduce omitted variable and endogeneity bias. Our contribution with respect to Akande et al. (2018), who find evidence for the competition-fragility view, is that we allow for a non-linear relationship between bank competition and credit risk. A related study carried out by Sarpong-Kumankoma et al. (2018) focused on the charter-value hypothesis of competition. More specifically, for a sample of 139 commercial banks in 11 SSA countries the authors find that higher market power (measured by the Lerner index) linearly increases bank profitability which in turn should enhance bank stability in the long run.

The recent literature has also emphasized the role of bank-specific characteristics and the macroeconomic environment (e.g., Salas and Saurina, 2002; Louzis et al., 2012; Castro, 2013; Klein, 2013; etc.), as well as the regulatory framework (e.g., Houston et al., 2010; Chen et al., 2017a; Sarpong-Kumankoma et al., 2018) in explaining bank performance and risk-taking. Our paper will also draw from these studies.

3. Data description

We obtain bank-level data on financial statements from Fitch Connect over the period 2000–15. Our initial sample covers 526 financial institutions located in 37 Sub-Saharan African countries. Where possible, we gather consolidated financial statements and if no consolidated statement exists (e.g. for foreign subsidiaries) or the reporting period is substantially larger on an unconsolidated basis (mainly small banks), we use the unconsolidated financial statement.[3] Since our study focuses on the credit risk of deposit-taking institutions, we exclude non-deposit-taking institutions from the sample.[4] Further, we eliminate banks and countries from the study for which we were unable to obtain relevant information to compute non-performing loans[5] or the macroeconomic and regulatory variables to parameterise the empirical model. Finally, where possible we use end-of-year financial statements (90% of the sample), while in the remaining cases we use financial information as of March (4%) and June (6%). After applying our filters, the final sample covers 221 deposit-taking institutions from 33 Sub-Saharan African countries.[6] Of the 221 banks, 81 are domestically owned (17 are public banks) and 140 are subsidiaries of foreign banks (86 are banks from African countries, 48 from advanced economies, and 6 from other emerging markets).

Table 2 reports the list and summary information for the sampled countries. As can be seen, total assets of the banks amounted to 310 billion USD at the end of 2015, corresponding to an average of 21.5% of GDP (or 72% of the entire SSA banking sector),[7] against 123% in developed countries (based on the Global Financial Development Database). The lowest asset-to-GDP ratios are observed in Gabon, Equatorial Guinea, Chad and Democratic Republic of the Congo (below 5%), whereas in Cape Verde and Kenya bank assets amounted to more than 65% of GDP. The low financial development in the region is also associated with a much higher fraction of non-performing loans compared to the advanced economies (see Fig. 1). On average, 8.4% of loans have become non-performing in SSA (compared to 1.8% in the advanced economies) over the entire sample period, even though there is important cross-country variation (see also Table 2).[8] Moreover, non-performing loans have declined importantly during the period 2000–08, however, since 2009 credit risks have increased and peaked in 2010 and 2015, respectively. The latter development is likely to be associated with the drop in commodity prices, the Nigerian banking crisis of 2009, and the regional slowdown in economic growth. In parallel, Fig. 2 shows that the average level of banks' market power (measured by the Lerner index) has fallen over time suggesting that banking markets in the region have become more competitive over the last two decades. The relative increase in bank competition is with 15% economically important, especially since 2007–08. This pattern reflects the establishment of new banks and the expansion of Pan-African banks in the region in recent years (Enoch et al., 2015; Jacolin and Noah, 2017). Fig. 3 illustrates the link between bank competition (Lerner index) and credit risk (the ratio of non-performing loans). There would appear to be a U-shaped relationship between bank market power and credit risk.

4. Econometric framework

4.1. Baseline model

To examine the determinants of credit risks, we use a dynamic panel regression. The baseline model is specified as follows:

$$NPL_{ijt} = \alpha_0 + \alpha_1 NPL_{ijt-1} + \varphi_1 Lerner_{ijt} + \beta X_{ijt} + \gamma M_{jt} + \delta O_{jt} + \alpha_i + \varepsilon_{ijt} \quad (1)$$

where NPL_{ijt} denotes the non-performing loan ratio[9] of bank i located in country j in year t, $Lerner_{ijt}$ represents the bank competition

[3] Due to the small size of many of the banks in our sample, the consolidated and unconsolidated statements are very similar and the latter often possess better reporting quality. Overall, our final sample mainly consists of unconsolidated statements (75% of the total).

[4] We cross-referenced the list of financial institutions obtained from Fitch Connect with the registry of licensed banking entities reported on the websites of the various central banks in order to distinguish between deposit-taking entities from the other types of financial firms.

[5] Some banks do not publicly disclose certain balance sheet items including impaired loans.

[6] Republic of Congo, Guinea-Bissau, Gambia and the Seychelles were excluded from the sample due to poor data quality. In addition, in order to focus on developing countries, we did not include South African banks in our sample.

[7] At the end of 2015, total assets of the entire banking sector (excluding South Africa) amounted to 429 billion USD (Jacolin and Noah, 2017).

[8] The non-performing loan ratio in the region showed some heterogeneity across banks of different ownership with foreign banks headquartered in Africa recording the lowest levels (7.6% on average) followed by foreign banks from developed countries (8.0%) and domestic banks (9.0%).

[9] In the robustness checks, we use two alternative measures of bank risk, namely loan loss provisions and *Z*-Score (distance-to-default). It is widely agreed that bank stability and credit risk are highly correlated, especially in small and retail-oriented banking systems.

Table 2
Characteristics of the database, 2000–2015.

Country	Banks	Foreign banks	NPL (% of loans)	Adjusted Lerner index	GDP (2015, USD bn.)	Bank assets (2015, USD bn.)	Total assets (2015, % of GDP)	Real GDP growth	CPI inflation
Angola	13	5	7.74	0.55	103.91	43.83	42.18	7.58	38.00
Benin	3	3	9.55	0.46	8.76	1.41	16.11	4.25	2.84
Botswana	10	7	4.50	0.52	16.01	7.04	43.95	4.25	7.72
Burkina Faso	1	1	6.74	0.55	11.67	1.17	9.98	5.51	2.33
Burundi	1	1	12.16	0.53	2.31	0.20	8.69	2.88	10.16
Cameroon	6	5	9.47	0.54	30.43	5.46	17.95	3.95	2.46
Cape Verde	3	2	8.64	0.33	1.82	1.49	82.09	5.13	1.94
Central African Republic	1	1	5.92	0.65	1.43	0.16	11.05	1.85	6.71
Chad	2	1	7.55	0.66	13.36	0.63	4.69	7.62	4.23
Congo, Dem. Rep.	4	4	3.96	0.43	29.70	1.56	5.24	4.9	27.07
Cote d'Ivoire	2	2	9.70	0.39	33.96	3.58	10.53	2.62	2.62
Equatorial Guinea	1	1	19.37	0.68	16.42	0.69	4.22	9.49	5.12
Ethiopia	3	0	7.55	0.74	48.33	16.37	33.88	9.00	12.9
Gabon	2	2	6.00	0.53	18.55	0.55	2.94	2.44	1.93
Ghana	15	11	11.24	0.55	46.50	9.88	21.25	6.25	16.1
Guinea	2	2	11.01	0.54	5.26	0.81	15.43	2.46	14.83
Kenya	35	13	11.00	0.49	52.20	35.32	67.66	4.46	9.72
Lesotho	2	2	4.59	0.50	2.92	0.34	11.60	3.97	7.10
Madagascar	2	2	7.36	0.62	9.93	0.68	6.87	3.2	9.34
Malawi	6	2	9.85	0.58	8.50	1.20	14.07	4.39	15.73
Mali	3	3	12.57	0.46	12.68	1.96	15.48	4.77	2.40
Mozambique	13	11	5.83	0.47	14.3	6.16	43.06	7.43	8.93
Namibia	3	2	1.74	0.41	14.75	4.71	31.91	4.92	6.73
Niger	2	2	5.38	0.56	7.63	0.44	5.72	4.67	2.15
Nigeria	20	3	10.23	0.37	461.85	136.00	29.45	6.84	11.54
Rwanda	4	4	11.62	0.37	8.00	0.66	8.20	7.66	6.53
Senegal	7	5	7.43	0.45	15.77	5.39	34.17	4.04	1.61
Sierra Leone	4	2	25.00	0.69	3.16	0.29	9.21	6.86	8.31
Swaziland	4	3	2.78	0.59	5.22	1.04	19.87	3.26	7.18
Tanzania	20	14	6.57	0.46	43.73	10.49	23.98	6.6	7.66
Togo	1	0	9.44	0.56	4.04	0.56	13.94	2.86	2.62
Uganda	17	15	4.90	0.47	26.26	5.37	20.46	6.5	7.25
Zambia	9	9	8.91	0.43	26.06	4.55	17.44	6.51	13.7
Total*/Average	221*	140*	8.45	0.49	33.50	9.39	21.31	5.12	8.65

Note: This table provides information for the sample countries. “Banks” denotes the total number of deposit-taking institutions (domestic and foreign) in a given country. Non-performing loans (NPL), real GDP growth and CPI inflation are expressed as percentages and are unweighted averages over the period 2000–2015.
Sources: Fitch Connect, WDI, IMF-IFS and author's own calculations.

indicator, X_{ijt} is a vector of bank-specific characteristics, and M_{jt} and O_{jt} denote the vectors of macroeconomic and other (structural and institutional) control variables (see Table 3). We also include bank fixed-effects α_i to account for time-invariant and unobserved differences in the loan quality across banks. The model is estimated in dynamic form by including a lagged value of non-performing loans to capture the persistence of credit risk over time (Salas and Saurina, 2002; Louzis et al., 2012; Jiménez et al., 2013).

The dependent variable is measured by impaired loans as a proportion of total loans. We use the Lerner index as a measure for bank competition and cross-check our results using alternative indicators for robustness. The vector X_{ijt} includes a set of bank-specific indicators that have been highlighted in the empirical literature as important drivers of credit risk, notably the net interest margin (net interest income divided by total assets), the loan-to-assets ratio, income diversification (non-interest income divided by total assets), capitalization (total equity divided by total assets), and bank size (logarithm of total assets). We instrument all these variables by their lagged values in order to mitigate any possible endogeneity problem, we may have in our model specification (Roodman, 2009a).

We use the two-step system GMM estimator rather than the difference GMM estimator because the former allows the introduction of more instruments by adding a second equation which should improve estimation efficiency. While this type of estimator is designed for our dynamic setting with a short time and large cross-sectional dimension, it can lead to biased results in small samples, especially when the number of instruments is large (Roodman, 2009a, 2009b). To reduce the possibility of such a concern, we use across all specifications less instruments than cross-sections, and we verify the robustness of our results using (i) less instruments and (ii) the fixed effects estimator, which does not rely on instruments but with the caveat of being biased in our setting (Nickell, 1981). Finally, to avoid that the standard errors are downward biased we use the Windmeijer (2005) finite-sample correction to reduce the possibility of spurious precision (Roodman, 2009a, 2009b).

To capture a possible non-linear relationship between bank competition and non-performing loans, we augment our baseline model with a quadratic term for the competition measure. The augmented model is thus specified as follows:

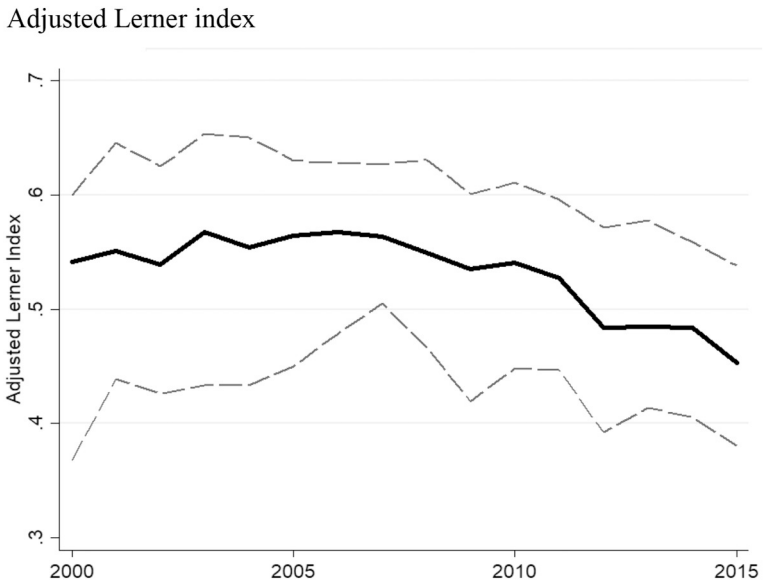

Fig. 2. Market power in Sub-Saharan Africa, 2000–2015.
Note: The figure provides information on adjusted Lerner index (lower value indicates more competition). It shows the 25th, 50th (median) and 75th percentiles of the distribution. All values are unweighted averages across banks and countries.
Sources: Fitch Connect and authors' own calculations.

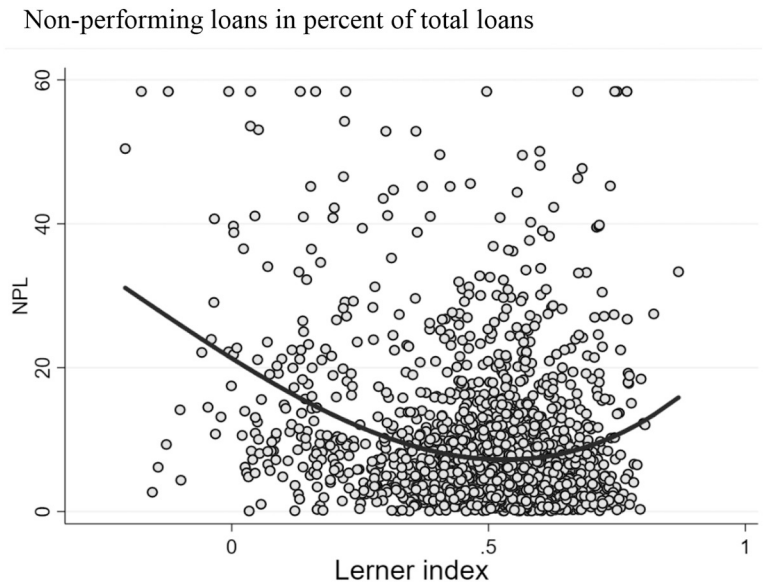

Fig. 3. Market power and credit risk in Sub-Saharan Africa, 2000–2015.
Note: The figure shows a scatterplot on the relationship between the adjusted Lerner index and credit risk for our sample of 221 banks from SSA.
Sources: Fitch Connect and authors' own calculations.

$$NPL_{ijt} = \alpha_0 + \alpha_i + \alpha_1 NPL_{ijt-1} + \varphi_1 Lerner_{ijt} + \varphi_2 Lerner_{ijt}^2 + \beta X_{ijt} + \gamma M_{jt} + \delta O_{jt} + \varepsilon_{ijt} \quad (2)$$

The relationship between credit risk and bank competition can then be summarized by:

$$\frac{\partial NPL_{ijt}}{\partial Lerner_{ijt}} = \varphi_1 + 2\varphi_2 \bullet Lerner_{ijt} \quad (3)$$

For example, if we find that $\varphi_1 < 0$ and $\varphi_2 > 0$, there would be evidence of a U-shaped relationship between credit risk and bank competition (as measured inversely by the Lerner index). In such a case, at lower levels, increased competition would be

Table 3
Description of the variables.

Variables	Description	Expected sign	Sources
Dependent variable			
NPL	Ratio of impaired loans to total loans		Fitch Connect
Independent variables			
Lerner	Adjusted Lerner Index	+/−	Own estimation
Lerner^2	Adjusted Lerner Index, squared term	+/−	
NIM	Ratio of gross interest and dividend income minus total interest expense to total assets	+	Fitch Connect
Loans	Ratio of gross loans to total assets	+	Fitch Connect
Income diversification	Ratio of total non-interest operating income to total assets	+/−	Fitch Connect
Bank size	Natural logarithm of total assets	+/−	Fitch Connect
GDP growth	Real GDP growth (year-on-year)	−	WDI
Government debt	Government debt as percentage of GDP	+	IMF-WEO
Inflation	Annual inflation rate	+/−	IMF-IFS
Economic concentration	Index of how much a country's economy and trade are concentrated in one or a few products	+	UNCTAD
Rule of Law	Index of agents' perception on the quality of contract enforcement, property rights, the police and the courts.	–	WGI

associated with lower credit risks (competition-stability view). However, once a certain threshold of competition is reached, heightened competition would lead to higher credit risks (competition-fragility view).

4.2. Bank competition indicator

Following a large body of literature, we decided to measure bank competition by the Lerner index cross-checking our results with the Herfindahl-Hirschman index (HHI) and the H-Statistic (Panzar and Rosse, 1987).[10] The former is a bank-specific measure of market power and calculated as a bank's mark-up (price minus marginal costs divided by the price), while the latter two are country-specific and calculated by the sum of banks' squared market shares (HHI) and the elasticity of bank revenues relative to input prices (H-Statistic). Of these three, our preferred measure is the Lerner index, as it allows capturing differences across banks (e.g. size and type), which is not the case for the HHI and H-Statistic on the country-level (Berger et al., 2004).[11] In a similar vein, Claessens and Laeven (2004) argue the HHI may not necessarily capture the degree of effective competition, which depends on the contestability of the system and other bank-specific factors.

To infer marginal costs for the computation of the Lerner index, we employ a trans-log cost function, which has been shown to be more efficient than other functional forms (Gagné and Ouellette, 1998). Our estimation strategy is also constrained by the low frequency (annual) and limited availability of our data, especially on the time-dimension. This means that we cannot rely on certain functional forms (such as Fourier) or certain non-parametric methods such as the smooth coefficient model applied by Delis et al. (2014) on a large number of daily observations. Similar estimation strategies have been used in related studies on the bank-level in the Sub-Saharan context, such as in Akande et al. (2018) and Sarpong-Kumankoma et al. (2018), and in the developing country context, such as in Turk-Ariss (2010).

The Lerner index is a measure of a bank's market power and defined as the ratio between the mark-up (price minus marginal cost) and price, and it should be zero in perfect competition but will increase in less competitive banking markets (Lerner, 1934). By taking this measure, we assume that there is a one-to-one mapping between market structure and competitive behaviour of banks: less competitive banking markets enhance market power and are associated with a higher Lerner index. The conventional form of Lerner index can be computed as follows:

$$Lerner_{it} = \frac{P_{it} - MC_{it}}{P_{it}} \tag{4}$$

where P_{it} is the average price of the banking output of bank i at time t, and MC_{it} is the marginal cost. The price is measured by the implicit interest rate on loans (interest income divided by total loans), whereas banking output is measured by the stock of outstanding loans, as has been done in Solís and Maudos (2008), Williams (2012) and Lapteacru (2017). We estimate marginal costs using the following trans-log cost function:

$$\ln(TC_{it}) = \alpha_0 + \alpha_1 \ln(Q_{it}) + \frac{1}{2}\alpha_2 \ln(Q_{it})^2 + \sum_{n=1}^{3} \beta_n \ln(w_{int}) + \sum_{m=1}^{3}\sum_{n=1}^{3} \beta_{mn} \ln(w_{imt} w_{int}) + \sum_{n=1}^{3} \gamma_n \ln(Q_{int}) \ln(w_{int}) + \delta_1 T + \frac{\delta_2}{2} T^2 + \delta_3 T \ln(Q_{it}) + \sum_{k=1}^{3} \varphi_k T \ln(w_{ikt}) + \varepsilon_{it} \tag{5}$$

[10] The meta-analysis on the competition-stability nexus of Zigraiova and Havranek (2016) suggests that 62.2% of the sampled studies have used the Lerner index or HHI, 15.7% the C3/C5 ratios, 9% the H-statistic, 7.5% the Boone indicator, and 5.2% employed less frequently used methods.

[11] In principle, the H-Statistic could be estimated at the bank-level, but this would require a long time-dimension for each bank.

Total costs TC_{it} are measured by the sum of personnel expenses, other non-interest and interest expenses, output Q_{it} by total loans, and w_{int} are three input prices (i.e., for labour, capital and funding). The price of labour is hereby proxied by the ratio of personnel expenses to total assets, the price of physical capital by the ratio of other non-interest expenses to fixed assets, and the price for borrowed funds by the ratio of interest expenses to total deposits and money market funding. We also include a time trend (T) and various interaction terms to control for unobserved determinants of total costs that are common to all banks over time (such as technological progress) and other time-variant factors (Maudos and Fernández de Guevara, 2004, 2007; Turk Ariss, 2010).

The estimated coefficients of the total cost function are then applied to compute marginal cost:

$$MC_{it} = \frac{\partial TC_{it}}{\partial Q_{it}} = \frac{TC_{it}}{Q_{it}}\left(\alpha_1 + \alpha_2 \ln(Q_{it}) + \sum_{n=1}^{3} \gamma_n \ln(w_{int}) + \delta_3 T\right) \tag{6}$$

Koetter et al. (2012) argue that the conventional approach of computing the Lerner index fails to consider the possibility that banks may choose not to exploit pricing opportunities resulting from market power. It also assumes both profit and cost efficiencies. Consequently, if banks do not set their prices optimally and do not make optimal choices regarding their inputs, the conventional Lerner index would not measure correctly the true market power. In order to capture such effects, the authors suggest an adjustment in form of the efficiency-adjusted Lerner index:

$$\text{Adjusted Lerner}_{it} = \frac{\widehat{PBT_{it}} + \widehat{TC_{it}} - \widehat{MC_{it}}}{\widehat{PBT_{it}} + \widehat{TC_{it}}} \tag{7}$$

where $\widehat{PBT_{it}}$ and $\widehat{TC_{it}}$ are the predicted values of pre-tax profit and total cost, respectively, scaled by bank output (total loans). We estimate Eq. (5) by employing a Stochastic Frontier Approach (SFA) with the cost efficiency option and extract $\widehat{TC_{it}}$ and $\widehat{MC_{it}}$. To estimate $\widehat{PBT_{it}}$, we use pre-tax profit as the dependent variable in the eq. (5) and run the SFA with the production efficiency option (Berger and Mester, 2003; Bos and Koetter, 2011).[12]

4.3. Other control variables

The net interest margin (NIM) is calculated as the ratio of gross interest and dividend income minus total interest expenses to total assets. The effect of the net interest margin on credit risks is ambiguous. On the one hand, higher margins could be an indication of higher credit risks, because they may point to banks that charge high interest rates due to a risky credit portfolio and/or the anticipation of losses (Angbazo, 1997; Salas and Saurina, 2002; Maudos and Fernández de Guevara, 2004; Fofack, 2005; Carbó-Valverde and Fernández, 2007). On the other hand, higher margins provide banks with an additional cushion to absorb adverse shocks, increase franchise values and thus lead to lower risk-taking incentives.

Loan growth represents a major determinant of loan defaults (Podpiera and Weill, 2008). Rapid credit growth is not problematic in itself, especially in African countries where financial development is low and economic development may go hand in hand with strong credit growth. But excessive growth can result in a reduction of credit screening and monitoring quality, that subsequently increases the probability of loan defaults. We therefore expect credit growth to affect credit risk positively. We use the loan-to-assets ratio to measure banks' credit growth history, as banks with larger loan portfolios are likely to have grown faster in the past, similar to Ghosh (2015) and Klein (2013).

Income diversification is measured by non-interest income as a proportion of total assets. The relationship between non-performing loans and income diversification is not clear. Whereas Ghosh (2015) and Louzis et al. (2012) document that more diversification reduces risk and improves loan quality, Lepetit et al. (2008) point out that some banks may also neglect screening and monitoring of borrowers when focusing on non-banking activities.[13]

We use the leverage ratio (total equity as a proportion of total assets) as a proxy of capitalization, much like Louzis et al. (2012), Klein (2013), Ghosh (2015), and Zhang et al. (2016). The impact of bank capitalization on credit risk is ambiguous. On one hand, a higher capitalization may reflect that the bank is more risk averse and thus operates with higher capital buffers and potentially with less non-performing loans. On the other hand, higher capitalization may be an indication that a bank's regulatory capital requirements are high due to a riskier asset portfolio. Managers in banks with low equity ratios (high leverage) may have incentives to engage in riskier banking activities, while releasing expenses on credit scoring and the monitoring of borrowers (Keeton and Morris, 1987; Berger and DeYoung, 1997).

Bank size (natural logarithm of total assets) is another potential determinant of credit risks. Salas and Saurina (2002) show that larger banks with more credit diversification opportunities can decrease the level of bad loans. Hu et al. (2004) argue that larger banks are in a better position to assess loan quality due to superior access to resources and economies of scale in information processing. The "*too big to fail*" hypothesis, on the other hand, highlights that larger banks may take more risks due to their implicit bail-out guarantee (Louzis et al., 2012; Brei and Gadanecz, 2012), and they hence may operate with higher non-performing loan ratios.

In addition to the bank-specific variables, macroeconomic factors are likely to influence non-performing loans. Following the current literature, we include real GDP growth to capture business cycle conditions and expect a negative relationship between

[12] The adjusted version of the Lerner index has also been used by Clerides et al. (2015), Kasman and Kasman (2015) and Lapteacru (2017).
[13] Also see Wagner (2010).

economic activity and non-performing loans (Al-Khazali and Mirzaei, 2017; Castro, 2013; Louzis et al., 2012; Salas and Saurina, 2002; Carey, 1998; Ruckes, 2004; Nkusu, 2011). The impact of inflation is ambiguous (Klein, 2013), as higher inflation reduces the real value of loans and can make debt servicing easier but also reduces the real income of borrowers, hence their ability to service debt. We also include public debt as a share of GDP (Louzis et al., 2012; Klein, 2013). Public debt may positively affect non-performing loans both through expenditure (wage bill, investment) or revenue effects to soften fiscal deficits (Perotti, 1996). In Sub-Saharan African economies, where a high share of public receipts may depend on commodity price fluctuations, we expect a feedback loop between public revenue, spending and public debt on one hand and defaults of both households and firms (through the accumulation or arrears for instance) on the other.

We control for both economic structure and the institutional environment. Following Fofack (2005), we include a measure of economic concentration[14] to capture macroeconomic vulnerability to external shocks. We expect a positive link between economic concentration and credit risk in Sub-Saharan Africa where most export sectors depend on external commodity demand. Finally, following the literature on *law and finance* (La Porta et al., 1998), we include in our model the quality of institutions by using an indicator on the rule of law to capture the quality of contract enforcement, property rights, and the political and legal system (Kaufmann et al., 2011).

5. Results

We estimate seven separate models for non-performing loans. The first includes only the linear term of the adjusted Lerner index. Specifications (2) to (4) include the Lerner index and its squared term where we vary the estimation method. The fifth includes the bank-specific control variables, and the sixth includes on top macroeconomic variables. The final specification incorporates all four sets of determinants: bank competition, bank-specific variables, macroeconomic and institutional indicators. The summary statistics for the regression variables are shown in Table 4, and the regression results are reported in Table 5.

In all of our dynamic models, the lagged dependent variable is significant, confirming the persistence of credit risk over time. This reflects that non-performing loans remain on the balance sheet for a certain time before they are written off. The Hansen test also validates the instruments used in all model specifications since we cannot reject the null hypothesis that the instruments are exogenous. We kept the number of instruments consistently below the number of cross sections. As Cuestas et al., 2020 we also report for each specification the inflection point corresponding to the optimal threshold, when the U-shape test (Lind and Mehlum, 2010) highlights a statistically significant non-linear relationship between bank competition and credit risk. We also report the 95% confidence interval based on the Fieller method (Fieller, 1954).

In the linear specification (1) shown in Table 5, a higher Lerner index (i.e. lower bank competition) is associated with better loan quality, giving support to the competition-fragility view. In specifications (3) to (7), the coefficient of the bank competition indicator is negative for the linear term but positive for the quadratic term and both coefficients are statistically significant. This implies that bank competition has been associated with more bank stability, but only up to a certain threshold after which more competition has increased bank fragility in Sub-Saharan Africa. The U-shaped relationship between competition and bank risk is in line with the theoretical predictions of Martinez-Miera and Repullo (2010), who argue that initially the reduction in the cost of credit brought about by more competition reduces borrowing costs, improves borrower repayment capacity and hence the non-performing loan ratio. However, as competition further increases, the loss of revenue stemming from price competition across banks erodes their cushions stemming from revenues (margin effect) with adverse effects on risk-taking incentives (Berger et al., 2009; Liu et al., 2013; Cuestas et al., 2020).

We also report the results obtained by using (i) the fixed effects estimator (Table 5, column (3)), and (ii) significantly less (collapsed) instruments (Table 5, column (4)). To avoid the Nickel bias in our dynamic panel setting (small T, large N dimension), we excluded in the fixed effects regressions the lagged dependent variable. Our main results are robust.

In the complete specification (7), the inflection point at which credit risks are lowest is equal to a Lerner index of 0.57 (compared to an average of 0.49 and a standard deviation of 0.15, see Table 4), which corresponds to the 70th percentile and it represents a significant part of the distribution. Fig. 4 visualizes the estimated relationship between bank competition (lower Lerner index) and credit risk. For instance, on average banks from Swaziland, Madagascar, Central African Republic, Chad, Equatorial Guinea, Sierra Leone, and Ethiopia recorded a higher market power than this threshold over the sample period (see Table 2). For these countries, enhanced bank competition would be associated with lower credit risks up to the optimal level of 0.57. One has, however, take into consideration the important foreign bank presence in most of these banking sectors and that the optimal level of competition differs across banks from Africa and those from developed countries (see discussion of Table 6 below). For the other 26 countries, the optimal level of competition has been reached and restrictions in bank competition would be associated with lower credit risks, again only up to the optimal level.

Apart from our competition measure, the only significant bank-specific determinant in Sub-Saharan Africa is the loan-to-assets ratio. Banks that are more involved in lending also report relatively more non-performing loans. This could be related to a high past growth of the loan book or lower screening standards due to the relatively higher cost of borrower screening and monitoring compared to other types of investments. The coefficient of real GDP growth is negative as expected, confirming the impact of the business cycle on loan quality (Castro, 2013; Louzis et al., 2012; Salas and Saurina, 2002; Carey, 1998; Ruckes, 2004; Nkusu, 2011).

[14] Economic concentration is a measure of the degree of product concentration provided by UNCTAD. An index value closer to 1 indicates that a country's trade sector is highly concentrated on a few products. On the contrary, values closer to 0 reflect diversification.

Table 4
Summary statistics for the regression variables.

Variable	Unit	Obs.	Mean	Std. Dev.	Min	Max
NPL	Percentage	1655	8.45	9.00	0.07	58.39
Adjusted Lerner Index	Index	1655	0.49	0.15	−0.20	0.82
NIM	Percentage	1655	5.93	3.34	0.62	31.18
Loans	Percentage	1655	52.80	14.61	8.03	87.95
Income diversification	Percentage	1655	3.87	2.18	0.10	15.36
Capitalization	Percentage	1655	12.90	6.64	0.42	71.82
Bank size	Logarithm	1655	12.82	1.39	8.91	16.33
GDP growth	Percentage	1655	5.56	3.19	−6.91	22.59
Government debt	Percentage	1655	38.74	21.34	7.28	150.23
Inflation	Percentage	1655	9.13	9.00	−1.89	108.90
Economic concentration	Index	1655	0.40	0.23	0.17	0.97
Rule of Law	Index	1655	−0.58	0.50	−1.70	0.67

Note: The sample period goes from 2000 to 2015. “Unit” denotes the measurement units of the regression variables. “Obs.” denotes the number of observations for the respective variable. The last four columns show the mean, standard deviation, minimum and maximum.

Table 5
Results for the baseline model.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
NPL, t-1	0.625***	0.584***		0.659***	0.597***	0.590***	0.601***
	(0.113)	(0.118)		(0.079)	(0.102)	(0.103)	(0.103)
Lerner	**−10.94****	**−55.92*****	**−37.57*****	**−64.15*****	**−54.47*****	**−55.02*****	**−51.48*****
	(4.558)	**(16.13)**	**(10.93)**	**(21.22)**	**(15.65)**	**(16.20)**	**(16.33)**
Lerner*Lerner		**49.78*****	**34.11*****	**57.17****	**48.32*****	**48.91*****	**45.40*****
		(15.53)	**(12.63)**	**(23.02)**	**(15.24)**	**(15.69)**	**(15.76)**
NIM					0.052	0.057	0.059
					(0.078)	(0.079)	(0.082)
Loans					**0.046****	**0.042****	**0.056****
					(0.021)	**(0.021)**	**(0.022)**
Income diversification					0.078	0.067	0.005
					(0.134)	(0.135)	(0.145)
Capitalization					0.019	0.032	0.034
					(0.043)	(0.044)	(0.047)
Bank size					−0.143	−0.052	−0.171
					(0.205)	(0.184)	(0.185)
GDP Growth						−0.062	**−0.071***
						(0.039)	**(0.038)**
Government Debt						**0.023****	**0.027*****
						(0.009)	**(0.009)**
Inflation						−0.004	−0.018
						(0.016)	(0.016)
Economic Concentration							**2.330*****
							(0.860)
Rule of Law							−0.621
							(0.401)
Constant	8.513***	17.75***	17.91***	19.36***	15.94**	14.48**	13.31**
	(2.972)	(4.884)	(2.432)	(4.663)	(6.564)	(6.458)	(6.525)
Observations	1655	1655	1655	1655	1655	1655	1655
Banks	221	221	221	221	221	221	221
Hansen test (1)	0.222	0.441		0.716	0.463	0.470	0.403
AR (2) test (2)	0.582	0.416		0.429	0.357	0.378	0.353
Instruments/Overall R2 (3)	100	100	0.097	17	106	109	111
Inflection point (4)		0.562***	0.551**	0.561**	0.564***	0.563***	0.567***
95% CI, Fieller method (5)		[0.460; 0.746]	[0.460; 0.940]	[0.499; 0.971]	[0.503; 0.698]	[0.506; 0.689]	[0.504; 0.729]

Note: The sample goes from 2000 to 2015. All estimations are based on the Arellano and Bover (1995) system GMM estimator, except for column (3) which is estimated by fixed effects. Robust standard errors are reported in brackets. (1) Reports p-values for the null hypothesis that the instruments used are not correlated with the residuals. (2) Reports *p*-values for the null hypothesis that the errors in the first difference regression exhibit no second-order serial correlation. (3) Reports the number of instruments, except for column (3) where the overall R2 is reported. (4) Reports the inflection point (threshold) of the relationship between the Lerner index and non-performing loans; the stars indicate the significance of the U-shape test of Lind and Mehlum (2010) for the null hypothesis of a monotone or inverse U-shape relationship. (5) Reports the 95% confidence interval for the optimal point. (***, **, *) indicate significance at the 1%, 5%, 10% level. Significant coefficients are in bold.

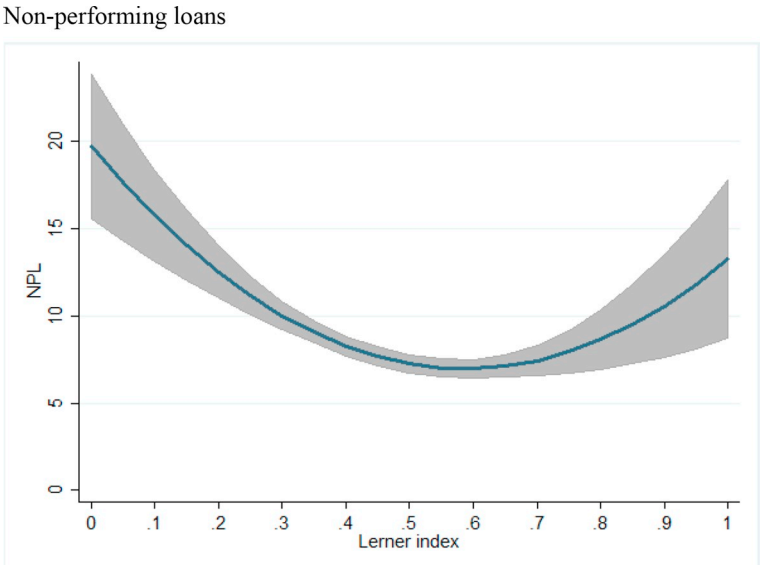

Fig. 4. Effect of market power on credit risk in Sub-Saharan Africa.
Note: The figure shows the relationship between the adjusted Lerner index and the non-performing loan ratio based on regression (7) in Table 5. The marginal effects are calculated at average values of the regression variables. The shaded area shows 95% confidence bands.
Sources: Fitch Connect and authors' own calculations.

Government debt is positively related to non-performing loans, suggesting a feedback loop between the fiscal stance of public sector, credit ratings for corporates, and credit risk (Louzis et al., 2012; Klein, 2013). Economic concentration has an adverse effect on non-performing loans pointing to the vulnerability of highly concentrated economies to external shocks (Fofack, 2005).

Next, we examine whether the ownership of banks and their size has an impact on the relationship between bank competition and credit risk. To this purpose, we interact the Lerner index and its square with different indicator variables on: (i) foreign banks, (ii) foreign banks from the African region, (iii) foreign banks with headquarters in the advanced economies, (iv) government-owned banks and (v) large banks. The different bank types are identified using a dummy variable that is equal to one if a bank is controlled by a foreign institution (48 entities are from the advanced economies, 86 from Africa) or a governmental institution (17 entities). The bank size variable is measured by a dummy variable that is equal to one if the relative size of a bank (total assets to the country's total assets) is larger than the 75th percentile of the distribution.

There is no consensus in the empirical literature on the impact of foreign bank entry on stability. On the one hand, foreign banks might be a source of stability in periods of local stress by virtue of their geographic diversification and access to internal capital markets (Dages et al., 2000; Crystal et al., 2001; De Haas and Van Lelyveld, 2010). Set against those benefits are fears of contagion from external crises, aggressive growth strategies, or the crowding-out of domestic lending to small firms (Peek and Rosengren, 2000; Clarke et al., 2005; Claessens and Van Horen, 2012; De Haas and Van Lelyveld, 2014; Mian, 2006; Gormley, 2010; Chen et al., 2017a). The results reported in columns (1) to (3) of Table 6 suggest that in Sub-Saharan Africa foreign ownership does not influence the U-shaped relationship between bank competition and credit risk. While our main results hold for domestic banks and foreign banks originating from Africa, we still find a non-linear relationship for banks from developed countries, but it is reversed. This implies that there exists an optimal level of competition, but this level differs across African banks and banks from developed countries and the dynamics are different. Compared to the optimal level of 0.57 for African banks' Lerner index, the inflection point for banks from developed countries is lower, i.e. at a Lerner index of 0.38 ($-51.43 + 74.23 / (2*(74.91–44.88))$. This is an important finding and of interest for policy makers.

Recent research also has focused on differences in the way private and state-owned banks may compete, a topic of interest in developing countries where state-owned institutions often hold substantial market shares (see Cull et al. (2017) for an extensive review). State-owned banks may have objectives other than profit maximization, such as fostering export, sectoral or regional development, or they may take into account lending externalities (Brei and Schclarek, 2015). In addition to their impact on these market segments where lending can be unprofitable and risky, these institutions usually operate with government subsidies and may be subject to politically connected lending problems, reducing market discipline and the incentives of these to compete (Krueger, 1974; La Porta et al., 2002; Berger et al., 2004). However, as highlighted in the literature, this depends on the institutional background of a country (Adrianova et al., 2012). As can be observed in column (4) of Table 6, government ownership does not affect the relationship between competition and credit risk in Sub-Saharan Africa after controlling for the quality of public institutions.

The literature has also investigated the impact of bank size on competitive conditions. Relative to large banks, small banks in developed countries tend to serve smaller local customers and provide more retail-oriented financial services (DeYoung et al., 2004). Banks of different sizes may also deliver their services using different technologies, with large banks developing costlier lending technologies (i.e. credit scoring) based on “hard” quantitative data, whereas small banks may rely more on technologies (i.e.

Table 6
Bank type, external shocks and regulation.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Foreign banks	Foreign, Africa	Foreign, Developed	Public banks	Large banks	External shocks		Financial development and regulatory factors				
NPL, t-1	0.610***	0.602***	0.612***	0.611***	0.600***	0.600***	0.649***	0.597***	0.605***	0.606***	0.656***	0.649***
	(0.125)	(0.108)	(0.107)	(0.095)	(0.100)	(0.103)	(0.068)	(0.102)	(0.116)	(0.107)	(0.106)	(0.102)
Lerner	**−62.34*** **	**−55.40*** **	**−51.43*** **	**−51.67*** **	**−52.19*** **	**−51.50*** **	**−43.73*** **	**−52.77*** **	**−48.26*** **	**−44.99** **	**−33.79** **	**−38.30*** **
	(20.49)	**(18.10)**	**(14.40)**	**(15.42)**	**(15.16)**	**(16.28)**	**(13.73)**	**(17.12)**	**(18.46)**	**(20.25)**	**(15.10)**	**(14.45)**
Lerner*Lerner	**53.09*** **	**49.20*** **	**44.88*** **	**44.56*** **	**44.74*** **	**45.40*** **	**37.13*** **	**46.05*** **	**41.20** **	**38.84** **	**28.52***	**34.31** **
	(20.00)	**(17.22)**	**(13.87)**	**(15.26)**	**(16.29)**	**(15.54)**	**(13.95)**	**(16.52)**	**(18.27)**	**(19.54)**	**(15.72)**	**(14.87)**
Lerner*Bank type	51.07	23.59	**74.23** **	18.47	40.80							
	(52.52)	(49.92)	**(31.37)**	(31.79)	(66.38)							
Lerner*Lerner*Bank type	−49.31	−25.71	**−74.91** **	−10.38	−31.99							
	(54.03)	(52.23)	**(33.76)**	(32.08)	(56.70)							
Financial crisis						0.064						
						(0.292)						
Commodities shock							**0.713***					
							(0.417)					
Financial development								**−0.052** **				
								(0.025)				
Bank Branches									**−0.111*** **			
									(0.040)			
Credit registry coverage										**−0.035*** **		
										(0.013)		
Bank entry requirements											0.051	
											(0.412)	
Longer Supervisor Tenure												**1.942*** **
												(0.685)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1655	1655	1655	1655	1655	1655	1655	1645	1523	1466	1363	1134
Banks	221	221	221	221	221	221	221	221	221	221	197	170
Hansen test (1)	0.333	0.354	0.547	0.354	0.436	0.401	0.452	0.465	0.443	0.345	0.228	0.569
AR2 test (2)	0.379	0.326	0.426	0.338	0.452	0.352	0.379	0.397	0.257	0.332	0.941	0.788
Instruments (3)	114	114	114	114	114	112	105	112	104	92	105	105
Inflection point (4)	0.587**	0.563***	0.573***	0.580**	0.583**	0.567***	0.581**	0.573**	0.585**	0.579*	0.592	0.558**
95% CI, Fieller method (5)	[0.508; 0.874]	[0.496; 0.713]	[0.499; 0.726]	[0.510; 0.789]	[0.483; 0.971]	[0.504; 0.714]	[0.501; 0.839]	[0.507; 0.763]	[0.514; 1.20]	–	–	[0.447; 1.141]

Note: The sample goes from 2000 to 2015. All estimations are based on the Arellano and Bover (1995) System GMM estimator. Robust standard errors are reported in brackets. In columns (1)–(5), the adjusted Lerner index is interacted with indicator variables for foreign banks (all, Africa, developed countries), public banks and bank size. The remaining columns include additional regressors in the baseline specification. (1) Reports p-values for the null hypothesis that the instruments used are not correlated with the residuals. (2) Reports p-values for the null hypothesis that the errors in the first difference regression exhibit no second-order serial correlation. (3) Reports the number of instruments. (4) Reports the inflection point (threshold) of the relationship between the Lerner index and non-performing loans; the stars indicate the significance of the U-shape test of Lind and Mehlum (2010) for the null hypothesis of a monotone or inverse U-shape relationship. (5) Reports the 95% confidence interval for the optimal point. (***, **, *) indicate significance at the 1%, 5%, 10% level. Significant coefficients are in bold.

relationship lending) based on "soft" information (Stein, 2002). As can be observed in column (5) of Table 6, we do not find evidence that the relative size of the banks affects the competition-stability relationship.

The next set of regressions investigates the impact of external shocks on credit risks. To this end, we include a variable identifying the global financial crisis (equal to one during 2008–10) and the commodity price shock of 2015 (equal to one in 2015). Our findings confirm the view that the African banking sector has been spared by the global financial crisis which might be due to the lower international exposure of local financial systems (Table 6, column (6)), but it has been vulnerable to the recent reversal in commodity prices (Table 6, column (7)).

We also inspect the effect of financial development on loan quality by using a measure on financial depth (domestic credit to the private sector divided by GDP) like Chen et al. (2017b), and the number of bank branches that operate in a given country (as a financial development and inclusion measure). As suggested by Honohan and Beck (2007), small financial systems are usually associated with inefficiencies in financial intermediation (e.g. due to high fixed costs). A more extensive coverage of bank branches helps reducing information asymmetries through better monitoring of borrowers. A large network of branches also provides better geographical coverage of banking services and thus diversification of local shocks, and it facilitates the transition from the informal to the formal sector. Our results indicate that both indicators are significant determinants of credit risks (Table 6, columns (8) and (9)). It appears that policies aimed at enhancing banking sector development in terms of size (credit outstanding) and scope (branch coverage) are associated with improvements in loan quality.

Finally, the literature has considered the regulatory framework as an important determinant of bank stability (e.g., Jappelli and Pagano, 1993, 2002; Houston et al., 2010; Barth et al., 2013a; Laeven and Levine, 2009). As suggested by Jappelli and Pagano (1993, 2002), information sharing among lenders attenuates the problems of information asymmetries, and can therefore increase lending activity and reduce default probabilities. In line with these studies, we investigate the impact of information sharing using data provided by the World Bank (Doing Business database).[15] We find that credit bureau (registry) coverage is associated with lower credit risk in SSA (Table 6, column (10)). This implies that loan quality is higher in countries where lenders share information, irrespective of the public or private character of the information sharing mechanism. Next, we use data provided by Barth et al. (2013b)[16] and examine the impact of bank entry requirements and longer supervisor tenure on credit risk.[17] While bank entry requirements are not significant (Table 6, column (11)), longer supervisor tenure is associated with higher credit risk (Table 6, column (12)).[18] This result suggests a need to improve supervision quality to the extent that supervisor mobility or turnover might be an indicator of staff quality. Further research is however welcome to disentangle how the determinants of staff turnover (availability of staff and administrative capacity, experience and training, corruption) interplay to justify this result. In this configuration, the turning points vary between 0.558 and 0.592 (see Table 6).

6. Robustness checks

In this section, we discuss several tests applied to assess further robustness of our regression results. To test whether the results are biased by larger banking markets,[19] we excluded in our regressions Angola, Ghana, Kenya, Nigeria and Tanzania, each at a time. The same approach is used with bank size (logarithm of total assets) and exclude big banks for the sample (corresponding to the 75–100% percentile). The results are reported in Table 7 (columns (1)–(6)). The U-shaped relationship between bank competition and credit risk remains valid.

Second, we test whether the results are sensitive to the measure of bank competition. We use three alternative measures: (i) the conventional Lerner index without adjustment, (ii) the Herfindahl-Hirschman index (HHI) and (iii) the H-Statistic. The conventional Lerner index is calculated according to Eqs. (4)–(6), the HHI is the sum of squared bank market shares in each country, and the H-Statistic is the elasticity of banks revenues relative to input prices.[20] The results shown in columns (7)–(9) reconfirm a U-shaped relationship between competition and credit risk.

Third, we use two alternative measures of bank risk: (i) loan loss provisions as a ratio over total loans (Fungáčová and Weill, 2013; Beck et al., 2013b) and (ii) *Z*-score (Laeven and Levine, 2009; Houston et al., 2010; Tabak et al., 2012; Chen et al., 2017a). The Z-score is a measure of overall bank risk and it captures how distant a particular bank is from insolvency. It is calculated as follows:

[15] We measure information sharing by credit bureau (registry) coverage, defined as the number of individuals and firms listed in a credit bureau or registry.

[16] Where yearly surveys are absent, we carried forward the values of the latest available data until the release of a subsequent survey (similar to Birchwood et al., 2017).

[17] "Bank entry requirements" is an index that ranges from 0 to 8 and a higher index value indicates greater stringency. "Longer supervisor tenure" is equal to 1 if the average tenure of current supervisors is greater than 10 years (which corresponds to the 75th percentile of the distribution).

[18] Alternatives variables such as independence of the supervisory authority (from government, banking sector, political parties) and official supervisory power (to take specific actions to prevent and correct issues) are also insignificant and have no bearing on the non-linear relationship between bank competition and credit risk in SSA. One possible explanation could be related to the slow process of structural reforms in Africa. The results are available upon request.

[19] We consider as a larger banking sector, any market made up of more than 10 banks in our sample associated with total assets greater than 9 billion USD in 2015 (see Table 2). Using this threshold, we identify five out of the top six banking sectors in SSA.

[20] The database on the HHI was developed at the Banque de France using BankScope and Fitch Connect as well as reports from individual banks. The H-Statistic is taken from the World Bank – Global Financial Development Indicators.

Table 7
Robustness checks (1).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Exclude Angola	Exclude Ghana	Exclude Kenya	Exclude Nigeria	Exclude Tanzania	Exclude Big banks	Lerner, conv.	HHI index	H-Statistic	Provisions	*Z*-Score
Dep. variable, t-1	0.613***	0.633***	0.492***	0.637***	0.628***	0.655***	0.687***	0.674***	0.674***	0.682***	0.209***
	(0.100)	(0.100)	(0.097)	(0.096)	(0.108)	(0.103)	(0.117)	(0.123)	(0.175)	(0.099)	(0.065)
Lerner	**−51.03*** **	**−50.51*** **	**−64.66*** **	**−100.83** **	**−48.39*** **	**−45.57*** **				**−36.27** **	**761.1*** **
	(16.65)	**(15.51)**	**(10.71)**	**(45.43)**	**(17.14)**	**(10.64)**				**(15.02)**	**(257.6)**
Lerner*Lerner	**45.29*** **	**45.69*** **	**55.01*** **	**95.57** **	**42.74*** **	**38.28*** **				**33.58** **	**−844.5*** **
	(16.09)	**(15.16)**	**(11.13)**	**(45.29)**	**(16.12)**	**(8.593)**				**(15.10)**	**(309.8)**
Lerner, conv.							**−19.70*** **				
							(6.155)				
Lerner*Lerner, conv.							**30.16*** **				
							(9.624)				
HHI								**−0.243*** **			
								(0.088)			
HHI*HHI								**0.004** **			
								(0.002)			
H-stat									**−23.73** **		
									(11.55)		
H-stat*H-stat									**27.17** **		
									(12.63)		
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1558	1563	1306	1554	1506	1229	1655	1638	661	1561	1438
Banks	208	206	186	201	201	189	221	221	183	217	221
Hansen test (1)	0.328	0.644	0.233	0.330	0.375	0.253	0.143	0.196	0.252	0.419	0.212
AR2 test (2)	0.501	0.802	0.215	0.316	0.255	0.570	0.831	0.701	0.811	0.827	0.171
Instruments (3)	104	104	104	54	104	104	104	104	51	111	47
Inflection point (4)	0.563***	0.553***	0.588***	0.528**	0.566**	0.595***	0.326***	29.83**	0.436**	0.540**	0.451***
95% CI, Fieller method (5)	[0.497; 0.732]	[0.493; 0.685]	[0.533; 0.689]	[0.500; 0.895]	[0.501; 0.731]	[0.475; 0.730]	[0.269; 0.406]	[22.10; 67.86]	[0.146; 0.678]	[0.487; 0.913]	[0.418; 0.562]

Note: The sample goes from 2000 to 2015. All estimations are based on the Arellano and Bover (1995) System GMM estimator. Robust standard errors are reported in brackets. 'Exclude' indicates that regressions are done without banks from the particular country (or size), 'Lerner, conv.'is the Lerner index without adjustment, 'HHI' the Herfindahl-Hirschman index, H-Statistic is the elasticity of bank revenues relative to input prices, 'Provisions' indicate that loan impairment reserves are the dependent variable and 'Z-Score' indicates that the Z-Score is the dependent variable. (1) Reports p-values for the null hypothesis that the instruments used are not correlated with the residuals. (2) Reports p-values for the null hypothesis that the errors in the first difference regression exhibit no second-order serial correlation. (3) Reports the number of instruments. (4) Reports the inflection point (threshold) of the relationship between the Lerner index and non-performing loans; the stars indicate the significance of the U-shape test of Lind and Mehlum (2010) for the null hypothesis of a monotone or inverse U-shape relationship. (5) Reports the 95% confidence interval for the optimal point. (***, **, *) indicate significance at the 1%, 5%, 10% level. Significant coefficients are in bold.

Table 8
Robustness checks (2).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Income level		Exclude countries ≤10 banks		Exclude foreign banks ≥50%		Inefficiency indicator		Profitability indicator	
Dependent variable, t-1	0.638***	0.631***	0.566***	0.521***	0.883***	0.491**	0.411***	0.287***	0.295***	0.232***
	(0.111)	(0.107)	(0.103)	(0.101)	(0.118)	(0.220)	(0.081)	(0.106)	(0.099)	(0.077)
Lerner	**−8.758****	**−48.92****	**−16.50*****	**−52.46****	**−9.216****	**−123.5*****	**−6.130*****	**−18.47*****	**44.69****	**126.4*****
	(3.702)	**(19.62)**	**(5.612)**	**(24.60)**	**(3.686)**	**(47.79)**	**(1.233)**	**(5.437)**	**(19.39)**	**(39.80)**
Lerner*Lerner		**44.36****		**46.50****		**100.25****		**17.25*****		**−98.98****
		(19.60)		**(22.97)**		**(45.74)**		**(5.675)**		**(44.04)**
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1655	1655	1058	1058	640	640	1655	1655	1654	1654
Banks	221	221	143	143	83	83	221	221	221	221
Hansen (1)	0.234	0.407	0.360	0.381	0.528	0.985	0.529	0.321	0.531	0.811
AR2 (2)	0.660	0.537	0.956	0.967	0.713	0.373	0.215	0.564	0.548	0.714
Instruments (3)	100	111	30	41	30	20	76	104	76	87
Inflection point (4)	–	0.551**		0.564**		0.616*	–	0.535***	–	0.638*
95% CI, Fieller method (5)	–	[0.499; 0.932]		[0.424; 1.911]		[0.538; 1.520]	–	[0.446; 0.734]	–	[0.520; 2.043]

Note: The sample goes from 2000 to 2015. All estimations are based on the Arellano and Bover (1995) System GMM estimator. Robust standard errors are reported in brackets. 'Income level' indicates the results when marginal costs are estimated for low-income countries separately from the other countries. 'Exclude countries ≤10 banks' indicates that countries with less than 10 banks are excluded from the sample, while 'Exclude foreign banks ≥50%' means that countries with majority foreign ownership are excluded. 'Inefficiency indicator' is measured by non-interest expense as a proportion of total assets. 'Profitability indicator' is measured by the ratio of net income to total banks' revenue. (1) Reports p-values for the null hypothesis that the instruments used are not correlated with the residuals. (2) Reports *p*-values for the null hypothesis that the errors in the first difference regression exhibit no second-order serial correlation. (4) Reports the inflection point (threshold) of the relationship between the Lerner index and non-performing loans; the stars indicate the significance of the U-shape test of Lind and Mehlum (2010) for the null hypothesis of a monotone or inverse U-shape relationship. (5) Reports the 95% confidence interval for the optimal point. (***, **, *) indicate significance at the 1%, 5%, 10% level. Significant coefficients are in bold.

$$Z - score_{ijt} = \frac{\overline{ROA_{ijt}} + Equity_{ijt}}{\sigma(ROA)_{ijt}} \quad (8)$$

where ROA_{ijt} denotes the return on assets of a bank (with the mean in the numerator), $Equity_{ijt}$ represents the ratio of total equity over total assets, and $\sigma(ROA)_{ijt}$ is the standard deviation of ROA. A higher score suggests a lower probability of bank insolvency. Using these alternative risk indicators (using a 3-year rolling window to estimate the mean and standard deviation for the Z-score), the U-shaped relationship between bank competition and bank risk remains significant (Table 7, columns (10) and (11)). In this case, the inflection points vary between 0.451 and 0.595.

Fourth, we also assess the sensitivity of the Lerner index estimate. In eq. (5), marginal cost is computed for all countries together assuming that the pattern of the cost function is the same across banks. Marginal costs are re-estimated by distinguishing low-income countries from others (as defined by the World Bank), in order to take account of the potential heterogeneity. We then use these marginal costs to estimate Eq. (7), and we obtain a new adjusted Lerner index. Once again, the non-linear relationship between bank competition and bank risk is robust (Table 8, columns (1) and (2)). We also run robustness checks on the sample composition and exclude countries (i) with less than 10 banks and (ii) with foreign banks owning more than 50% of the banking industry. The results shown in columns (3)–(6) confirm that our findings of a U-shaped relationship remain valid for the different samples.

Last, we investigate how bank competition affects bank efficiency and profitability, since both are linked to banks' risk-taking incentives. To this purpose, we replace in our regressions the dependent variable with a bank inefficiency indicator (non-interest expenses over total assets) and a profit margin measure (net income over total revenue). The results are reported in Table 8 (columns (7)–(10)). We find a non-linear relationship between bank competition and the two indicators on inefficiency and profitability. More specifically, the findings suggest that an increase in competition initially increases bank profitability by efficiency gains associated with better practices (reduction in administrative expenses, lower cost of borrower screening and monitoring). Above a certain threshold, however, further competition is associated with lower profit margins and higher inefficiencies enticing banks to engage in riskier activities.[21]

7. Conclusion

While this study mainly investigates the relationship between bank competition and credit risk, this paper sheds light on many other factors in the banking sectors of Sub-Saharan Africa. Its results are thus both informative and important for policy makers concerned with banking sector stability in developing countries.

First, in line with recent literature on this topic, we find robust evidence of a U-shaped relationship between bank competition and credit risk. In the baseline model, we find that the optimal threshold for the Lerner index is 0.57, with a 95% confidence interval in the range between 0.50 and 0.73. Up to this threshold, higher levels of bank competition are associated with lower credit risks, beyond this point more competition increases credit risk. This implies that the efficiency gains of heightened bank competition have to be counterweighted against the potential risks. The results are robust for different measures of competition and bank risk, as well as for different sample compositions. Interestingly, we find that the optimal level of competition differs across African banks and banks from developed countries, for which the optimal threshold is lower.

In terms of policy implications our findings suggest that heightened competition should be accompanied by policies that specifically target financial stability of deeper and more integrated banking systems. In other words, policy makers should encourage bank competition when the banking sector relatively concentrated but only up to a certain threshold.

Second, our study sheds light on the importance of business cycles, economic structure and financial deepening in determining credit risks in Sub-Saharan Africa. More diversified countries experience lower levels of credit risks. According to our results, policies aimed at enhancing banking sector development in terms of size (credit outstanding) and scope (branch coverage) are associated with improvements in loan quality, for instance, by lowering the concentration of bank portfolios. Our study also highlights the impact of government indebtedness in determining credit risk. In SSA countries, government interactions with the banking systems are multifaceted – large share of public servants and public enterprises in the client base, frequency of public domestic arrears that may hinder the activity of small firms – and further work is needed to study the components of this feedback loop.

Finally, our results contribute to the current debate on the importance of the business and institutional environment in which banks operate. Our study points to the impact of credit registries in lowering credit risk, suggesting that other structural and institutional characteristics (quality of accounting, mobilization of collateral and size of the informal sector) may be instrumental in reducing information asymmetries and improving bank stability. The quality of supervision (shorter tenure of supervisors) also matters in reducing credit risks, pointing to the need to reinforce staff and administrative capacity of domestic supervisors.

We believe further research is needed to uncover credit risk determinants specific to developing countries, as well as macro-financial and prudential regulations that will not hinder the financial development necessary for their economic development while ensuring the financial stability necessary to make it sustainable.

[21] We reach similar results when using the cost-income ratio as an alternative measure for bank inefficiency and the return on equity as an alternative measure for profitability.

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