Bank productivity in Africa

Sarah Beatson Nartey, Kofi A. Osei and Emmanuel Sarpong-Kumankoma
Business School, University of Ghana, Accra, Ghana

Abstract

Purpose – The purpose of this paper is to provide a total factor productivity index for the African banking industry. It also investigates the impact of some internal and external determinants affecting bank productivity.
Design/methodology/approach – The biennial Malmquist productivity index and various regression models (ordinary least squares, Tobit and truncated bootstrapped regression) are employed in analyzing data from 120 banks in 24 African countries from 2007 to 2012.
Findings – The results indicate a general decline in productivity of banks in Africa, largely due to inadequate technological progress. State banks are found to be more productive than foreign and private banks. The regression analyses showed that non-executive directors, leverage, management quality, credit risk, competition and exchange rate have significant impact on bank productivity, but ownership and CEO-duality do not.
Practical implications – The results have implications for management of banks, governments and regulators. It shows the need for policy and investments that improve state-of-the art technology. The findings also seem to suggest poor management practices in input usage, especially in operational management, as well as costs emanating from non-interest sources. Bank managers need to address these deficiencies to improve productivity in African banking markets.
Originality/value – A major contribution of this paper is the productivity index provided for the African banking industry. This study is also the first to apply the biennial Malmquist to analyze productivity in the African banking industry.

Keywords Efficiency, Banks, Productivity, Biennial Malmquist index
Paper type Research paper

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1. Introduction

The pivotal role played by banks in financial intermediation (Berger and Humphrey, 1997) and resource allocation (Gyamerah and Amoah, 2015; Isik, 2007), and their contribution to economic growth and development are well-established. Consequently, bank productivity studies have been of great interest among academic researchers, managers and policy makers (Casu *et al.*, 2004; Berger and Humphrey, 1997). Studies on bank efficiency assist regulators to determine appropriate policy tools that would provide suitable environment for optimum performance of financial institutions. However, studies on bank productivity provide additional insight by evaluating changes in efficiency between different time periods. Productivity studies are therefore beneficial to bank management and regulators by providing an understanding of the evolution of performance overtime (Alhassan and Biekpe, 2016).

Indeed, a bank which is more profitable in financial reports might not be actualizing real profits. However, a productive bank proves its ability to manage its resources to produce optimal output. Thus, a bank might be profitable but not productive. Consequently, productivity evaluations in the banking sector have gained interest among key stakeholders. A productivity increase improves cost efficiency, proper allocation of resources, better performance, improved service quality and a general increment in the entire economy's productivity. Even so, only a few bank productivity studies have been carried out in developing countries, especially in Africa.

Besides, the biennial Malmquist productivity index (BMPI) which was pioneered by Pastor *et al.* (2011) has few applications in the banking industry (Mohammadi and Yousefpour, 2014; Tohidi *et al.*, 2010). The Index solves the linear programming infeasibilities associated with the

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traditional Malmquist productivity index (MPI). In solving these infeasibilities under variable returns to scale (VRS), three proposed VRS-based Malmquist indices could be used. They include the sequential Malmquist (Shestalova, 2003), global Malmquist (Pastor and Lovell, 2005) and the biennial Malmquist (Pastor *et al.*, 2011). However, the sequential Malmquist index ignores ascertaining technical regress (Shestalova, 2003). With the global Malmquist, although it is transitive, it entails recalculation of the index whenever extra time periods are added to the sample (Pastor *et al.*, 2011). On the other hand, the biennial Malmquist provides a separate frontier that serves as a reference by enveloping all observations from the time periods, thereby solving the linear programming infeasibilities.

In their study, Pastor *et al.* (2011) compared the BMPI to the sequential Malmquist index and the global Malmquist index. Following the application of all three techniques to 93 US electricity generating firms for the periods 1977, 1982, 1987 and 1992, they observed high possibility of loss of information due to infeasibilities from the adjacent Malmquist index. Also, they noted distortion of productivity estimates when additional time periods are added to the existing data. Again, Vidal *et al.* (2013) assessed the quality of wines by estimating productivity changes using the biennial Malmquist index. Their findings showed a regress in productivity in two adjacent periods. The reasons for the decline of the two adjacent periods were retrogressions in technological innovations and efficiency changes (EC), respectively.

Owing to international financial market integration, deregulations and technological innovations in the banking industry, growth opportunities have been created (Robin *et al.*, 2018). These growth prospects have invariably increased competition. To overcome this, banks are posed with challenges in remaining productive. Factors that influence financial performance spur from bank-specific (e.g. bank size, leverage, net interest margin, etc.), industry-related (e.g. ownership and corporate governance) or macroeconomic environment (e.g. GDP, exchange rate and inflation). In addition, the literature focuses analysis of these factors mostly on profitability (Athanasoglou *et al.*, 2008; Pasiouras and Kosmidou, 2007; Garcia-Herrero *et al.*, 2009). Again, conclusions drawn from country-specific and regional boundaries (Mia and Soltane, 2016; Staikouras and Wood, 2003; Molyneux and Thornton, 1992) have been inconclusive.

The African banking market serves as a fertile ground for a study of the level of productivity and the factors driving it. Although, the banking industry in Africa has improved, the industry is still facing challenges with respect to the factors that affect its productivity, such as increasing competition (arising from widespread deregulation) and slow adoption of technological innovation (partly due to inadequate infrastructure). Generally, banking markets in this region are less competitive compared to other regions of the world. African banks are also well-capitalized, quite liquid, more profitable and fairly stable (Beck and Cull, 2013; Honohan and Beck, 2007; Moyo *et al.*, 2014; Beck *et al.*, 2011). However, due to the financial deregulation exercise embarked upon in most African economies, more foreign bank representatives have established their presence in the industry. As a result, the banking sector is either dominated by state-owned banks or by a few large, sometimes foreign banks (Allen *et al.*, 2011). Again, according to Allen *et al.* (2011), a common feature of African banking industry is evidenced in the large investment of government securities in the form of treasury bills. This reflects in the low contribution provided to private sector development. All these peculiar characteristics of the African banking markets can have implications for their productivity in ways that may be different from what has been observed in other regions of the world.

Indeed, it is known in the literature that the form of ownership structure has an influence on bank productivity. For instance, in developing countries, private-owned banks are likely to be more productive than state-owned banks due to the chance of mismanagement of state-owned banks (La Porta *et al.*, 2002). Mostly characterized by superior technology, skilled labor, diversification and larger scale of operations, empirical literature establish reasons for higher productivity of foreign banks over state and private banks in Australia

(Sturm and Williams, 2004), China (Huang and Zeng, 2011), India (Casu *et al.*, 2013), Latin America (Sáez-Fernández *et al.*, 2015), Malaysia (Sufian and Kamarudin, 2014), Poland (Havrylchyk, 2006), Taiwan (Chiu *et al.*, 2013), Turkey (Isik, 2007) and developing and transition countries (Micco *et al.*, 2007; Bonin *et al.*, 2005).

Other empirical findings including Kamarudin *et al.* (2017), Claessens and Van Horen (2012), Sufian (2011) and DeYoung and Noelle (1996) have established otherwise, mostly due to the home field advantage hypothesis propounded by Berger *et al.* (2000). This is so because the domestic banks (state and private banks) have a comparative advantage in understanding and relating well with the indigenous market than the foreign banks. Besides, the foreign banks provide some form of competition, rendering the domestic market to be more productive.

Again, the efficiency studies conducted in Africa have been limited to cost and technical efficiencies using either parametric approach (Saka *et al.*, 2012; Aboagye, 2012) or non-parametric approach (Alhassan and Ohene-Asare, 2016; Ongore and Kusa, 2013; Mlambo and Ncube, 2011; Ohene-Asare and Asmild, 2012). To the best of our knowledge, only few productivity studies have been done (Jreisat and Hassan, 2016; Alhassan and Biekpe, 2016; Maredza and Ikhide, 2013) in Africa. Also, no study in Africa has applied the BMPI to the banking industry. Most of the banking productivity studies have been done in the USA and other developed countries which have different socio-cultural, legal and financial environment that does not make the application of their findings to the African context feasible (Alhassan and Biekpe, 2016; Zeitun and Tian, 2007). Furthermore, due to lack of state-owned banks in the US banking industry (Altunbas *et al.*, 2001), it does not make it comprehensive enough to directly apply to the African context where there are considerate presence of banks owned by governments (Sufian and Kamarudin, 2014).

Thus, the dearth of productivity studies in Africa and the varying conclusions drawn in the extant literature, coupled with the peculiar institutional environment provide motivation for the current study. The purpose of this study is to analyze the productivity of banks in Africa, using the BMPI approach (Pastor *et al.*, 2011), which has few applications in the banking industry, in general, and none in the African context in particular. Furthermore, to ascertain the sources of the productivity changes, we decompose the index into efficiency change (EC), technology change (TC) and scale change (SC) among three classes of ownership of African banks. Finally, in view of the ongoing debate about the appropriate model to use in the second stage regression (Simar and Wilson, 2007, 2011; Hoff, 2007; Banker and Natarajan, 2008; McDonald, 2009; Banker *et al.*, 2019), we adopted the most commonly used approaches in the literature, ordinary least squares (OLS), Tobit and truncated bootstrapped regression, in order to deduce the effects of bank-specific, industry and macroeconomic factors on bank productivity.

This paper contributes to empirical literature in many ways. A major contribution of this paper is the productivity index provided for the African banking industry. Productivity studies carried out in Africa focused on particular countries as evidenced in Alhassan and Biekpe (2016) and Maredza and Ikhide (2013). This study is also the first to apply the biennial Malmquist to analyze productivity in the African banking industry. Finally, the study empirically test the home field advantage and global advantage hypotheses propounded by Berger *et al.* (2000) in relation to foreign banks and local banks in Africa.

The remainder of the paper is organized as follows. Section 2 provides a review of the literature. Section 3 offers a synopsis of the African banking industry, while Section 4 describes our methodology and data sampling. Section 5 discusses empirical results and the regression estimates. At last, Section 6 concludes the paper.

2. Literature review

2.1 Bank productivity

Studies on productivity in banking sector abound in literature. MPI, a productivity measure, has evolved and been extended. Notable among them are the sequential Malmquist index

(Shestalova, 2003), the cost Malmquist index (Maniadakis and Thanassoulis, 2004), the global Malmquist index (Pastor and Lovell, 2005), the profit Malmquist index (Tohidi *et al.*, 2010) and biennial Malmquist index (Pastor *et al.*, 2011).

One of the pioneer applications of Malmquist productivity change began with Berg *et al.* (1992) which focused on the Norwegian banking system during 1980–1989. The finding revealed a decrease in productivity pre deregulation and an increase after the deregulation. A study conducted by Wheelock and Wilson (1999) examined productivity change on US commercial banks from 1984 to 1993 and found a decline in the overall total factor productivity. Motivated by the 1997 Wallis Report, Sathye (2002) also conducted productivity analysis for 17 locally incorporated banks in Australia using MPI. He reported a decline in total factor productivity of 3.5 percent for the period 1995–1999. Murillo-Melchor *et al.* (2009) analyzed 14 EU countries from 1994 to 2000. A focus on only commercial banks, found a significant productivity growth of 3.3 percent for the overall period of 1995–2001, with no remarkable differences in the sub-periods (1995–1998 and 1999–2001).

In the African context, however, a lot of efficiency studies have been carried out among financial institutions. In Ghana, Bokpin (2013) used stochastic frontier analysis to analyze 26 banks during 1999–2007. His results showed foreign banks being cost efficient but not necessarily profit efficient than domestic banks. He also found bank size to have strong significant effect on profitability, leading banks to making riskier loans that invariably increases loan loss provision. Adopting data environment analysis (DEA) to estimate the technical and scale efficiencies of 16 banks covering the period 2000–2006, Akoena *et al.* (2013) concluded that, contrary to the small banks, large banks are associated with decreasing returns to scale. Again, technical efficiencies of six large banks are marginally lower (97.7 percent) than the smaller banks of 98 percent. With their analysis, their submission was not in favor of bank mergers for the purposes of efficiency improvement. Hauner and Peiris (2008) studied the competition and efficiency in the Ugandan banking sector. They indicated the significant increase of efficiency as a result of competition. However, following the banking reforms, larger banks and foreign banks (and not smaller banks) are major benefactors of the efficiency benefits. More recently, Sarpong-Kumankoma *et al.* (2017) also found that for the Sub-Saharan Africa region, less competition leads to greater bank cost efficiency, but the effect is weaker with higher levels of financial freedom.

There are few studies that address the issue of productivity changes in the African banking industry. The few research studies conducted have focused on individual countries instead of a contextual outlook among countries. Alhassan and Biekpe (2016) used Malmquist index to study 18 banks in Ghana from 2003 to 2011. Using the MPI in estimating productivity scores, their results revealed a general improvement in overall productivity with the source attributable more to improvements in EC. In the second stage regression analysis, excluding size (dummy), income diversification, market structure, risk and leverage were negatively related to productivity growth. The study threw more light on the challenge of technology regress in the industry in adapting new technologies for product development and innovation as against the managerial strategies banks (especially small banks) use in order to "catch-up" with their peers in the industry. For future research, the paper proposed the inclusion of corporate governance variables in examining its effect on productivity. Maredza and Ikhide (2013) evaluated the impact of the global financial crisis on the productivity of the South African banking industry. Their findings indicated a mild deterioration in efficiency and productivity scores during the crisis period in 2008–2010. In their second stage analysis, the considerable decline of 16.96 percent efficiency score was attributed to the crisis period whereas the bank size, non-performing loans, profitability, non-interest income and cost to income ratio variables appeared to be significant factors to bank performance.

2.2 Determinants of bank productivity

The current study considers the impact of ownership identity on productivity. Studies on developing and transition economies have been documented on the higher performance of foreign banks than their domestically owned peers from the banking industry (Isik, 2008; Bonin *et al.*, 2005). For instance, foreign banks (de novo banks) in Turkey were found to exhibit higher productivity (Isik, 2008).

In spite of the remarkable feats of foreign-owned banks in the banking industry, growing empirical evidence suggest higher x-efficiency by domestic banks (state and private) (Sufian, 2011; Ataullah *et al.*, 2004) whereas others show the irrelevance of ownership (Sufian and Kamarudin, 2014; Molyneux and Thornton, 1992). Aside an established fact of the foreign banks' influence on domestic banks regarding their technological prowess and innovativeness, it is imperative to assess their impact on the domestic (private and state) productivity (Claessens *et al.*, 2001).

Empirical evidence reviewed previously have established foreign banks higher performance than their domestic peers in developing and transition economies (Bonin *et al.*, 2005; Micco *et al.*, 2007), although not so in developed economies (Claessens *et al.*, 2001). These findings were classified in Berger *et al.* (2000) into two alternative hypotheses: home field advantage hypothesis (Sufian and Habibullah, 2016; Miller and Parkhe, 2002) and the global advantage hypothesis (Sturm and Williams, 2004). In the context of African banking, no studies have tested these hypotheses.

Many empirical works have also assessed the impact of corporate governance on performance within the banking sector (Akbar *et al.*, 2016; Liang *et al.*, 2013). But in spite of a growing body of literature, there is evidence of frequent analysis of board size, board composition and managers' equity holding. Literature on other corporate governance variables such as CEO duality (CDUA) and non-executive directors (NED) are sparse. Therefore, linking these corporate governance variables to bank productivity in the African context will provide a more dynamic performance review (Alhassan and Biekpe, 2016).

A key determinant of a bank's performance is its size. However, there have been varying conclusions on the relationship between size and performance in the literature. The size can influence whether a bank enjoys economies or diseconomies of scale in cost of gathering and processing information. Bank size was negatively related to profitability, according to a study by Pasiouras and Kosmidou (2007). In an empirical study by Olson and Zoubi (2011), however, this relationship was positive among MENA banks. Athanasoglou *et al.* (2008) also provided evidence that the profitability of Greek banks are shaped by internal and macroeconomic factors without bank size making any significant impact on profitability.

The level of concentration affects competition which invariably affects productivity. Williams (2003) found that domestic market concentration may decrease foreign bank profits. They have less control on their costs as they enjoy market power. On the other hand, Bourke (1989) indicated a positive association between higher concentration and high profitability. Berger (1995), however, argued that such relationship may be affected by other causes. He found a rather negative relationship between concentration and performance. Short (1979) also argued that such banks/firms enjoy non-competitive pricing in highly concentrated markets. Thus, it gives such banks room to make more profits.

The level of risk of bank also depends on the composition of its assets and liabilities. A bank with a higher loan to asset ratio is expected to be more efficient in generating profits (Robin *et al.*, 2018). Furthermore, a recent paper by Fernandes *et al.* (2018) found credit risk to be negatively associated with efficiency. They emphasized the knowledge of risk averseness by banks to maximize efficiency, thereby tightening their risky loans' monitoring. Leverage was positively associated with profitability according to Sufian (2011). According to their study conducted in Malaysian banking sector, more equity is held by the banks that engage in riskier operations.

Empirical findings about management quality show positive impact on productivity, affirming the expense preference behavior (Sufian, 2011). Literature also suggests that the economic and environmental conditions that banks operate in influence them. Therefore, external determinants such as the macroeconomic factors may influence bank performance. GDP growth had negative impact on banks' return on assets among a sample of banks in thirteen EU banking markets (Staikouras and Wood, 2003). However, Pasiouras and Kosmidou (2007) found a positive association with GDP growth and bank performance. Again, while Kosmidou (2008) identified a negative association of inflation with bank performance, Perry (1992) argued that inflation can either be anticipated or unanticipated. If unanticipated, banks costs increase due to lack of time in adjusting interest rates. However, if fully anticipated, there is an inclusion of inflation premium in the interest rate calculation. Thus, there is a fall in a bank's liabilities in real terms.

3. A synopsis of the African banking system

Most of the African banking systems comprise the deposit taking institutions and the central banks of the respective economies. The latter which works with the Ministry of Finance, under the auspices of the government, controls the banking industry. They formulate and implement robust regulatory frameworks that spur the affairs in the system. The deposit taking institutions are mainly locally established private and public banks. However, due to the financial deregulation exercise embarked upon in most African economies, more foreign bank representatives have established their presence in the industry. Table I provides the percentage of foreign banks to the total banks in the industry.

From Table I, it can be observed that there has been a steady increase in the total number of foreign banks. A particularly striking observation is in the period 2008–2010, which saw a rather marginal increase in foreign banks. In Table II, it can be observed that across Africa, from 2004 to 2013, there was a fluctuation in the proportion of total assets held by foreign banks. With the exception of 2006 and 2013, the proportion of assets held by foreign banks experienced some decreases and marginal increases.

Table I. Percentage of foreign banks to total banks

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Africa	39	39	41	39	41	43	46	49	50	51	50	51	52	52
North Africa	35	37	38	36	39	41	44	46	49	49	48	49	50	50
West Africa	42	43	42	42	44	46	47	48	52	53	52	54	56	56
East Africa	32	33	36	33	36	37	40	42	44	44	43	45	46	46
Southern Africa	37	38	40	38	41	43	45	47	49	50	49	51	51	52

Source: Compiled by authors from World Bank data

Table II. Percentage of foreign bank assets

Location	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Africa	37.69	37.87	43.92	39.42	41.53	39.82	37.66	39.97	39.81	45.03
North Africa	8.41	5.93	13.80	13.69	16.40	14.57	13.98	16.90	14.00	19.97
West Africa	55.65	64.44	42.48	40.79	44.85	44.15	42.13	57.20	50.62	16.00
East Africa	54.96	67.02	68.44	59.54	52.96	45.76	38.70	34.23	46.09	51.04
Southern Africa	60.36	58.41	59.47	62.32	62.25	61.09	60.37	58.26	56.25	59.91

Source: Compiled by authors from World Bank data

4. Methodology

4.1 Estimating and decomposing productivity: biennial Malmquist index

In estimating bank productivity, the biennial Malmquist index is employed because it provides a separate frontier that serves as a reference by enveloping all observations from the time periods, thereby solving the linear programming infeasibilities faced by sequential Malmquist (Shestalova, 2003), and global Malmquist (Pastor and Lovell, 2005). It also provides the source of the productivity by decomposing the index into biennial pure technical change (BTC), biennial pure efficiency change (BPEC) and biennial scale change (BSC). The biennial CRS Malmquist index ($BMPI_c$) can be estimated with reference to a biennial technology set that takes into account both time periods $(x^t, y^t, x^{t+1}, y^{t+1}) \in \varphi^B$. This can be expressed as follows:

$$BMPI_c\left(x^t, y^t, x^{t+1}, y^{t+1}\right) = \varphi_c^B\left(x^t, y^t\right) / \varphi_c^B\left(x^{t+1}, y^{t+1}\right), \tag{1}$$

where, $BMPI_c$ the BMPI under constant returns to scale; $(x^t, y^t, x^{t+1}, y^{t+1})$ the input and output mix in periods t and $t+1$; $\varphi_c^B\left(x^t, y^t\right)$ the efficiency score of an input and output mix in period t with respect to the biennial frontier under constant returns to scale; $\varphi_c^B(x^{t+1}, y^{t+1})$ the efficiency score of an input and output mix in period $t+1$with respect to the biennial frontier under constant returns to scale.

Under the VRS assumption, the above equation could be remodeled by changing the subscript as follows:

$$BMPI_v\left(x^t, y^t, x^{t+1}, y^{t+1}\right) = \left[\varphi_v^B\left(x^t, y^t\right) / \varphi_v^B\left(x^{t+1}, y^{t+1}\right)\right]. \tag{2}$$

Equation (2) could be further decomposed into three components (Ray and Desli, 1997) made up of the BPEC, the BTC and the BSC. The biennial pure EC, like the adjacent Malmquist index, is given as follows:

$$BPEC_v\left(x^t, y^t, x^{t+1}, y^{t+1}\right) = \left[\varphi_v^t\left(x^t, y^t\right) / \varphi_v^{t+1}\left(x^{t+1}, y^{t+1}\right)\right]. \tag{3}$$

The technical change/TC is derived by finding the ratio of the $BMPI_v$ in (2) and BPEC in (3) as defined in the following equation:

$$BTC_v\left(x^t, y^t, x^{t+1}, y^{t+1}\right) = \frac{BMPI_V\left(x^t, y^t, x^{t+1}, y^{t+1}\right)}{BPEC_V(x^t, y^t, x^{t+1}, y^{t+1})} = \frac{\varphi_v^B\left(x^t, y^t\right) / \varphi_v^B\left(x^{t+1}, y^{t+1}\right)}{\varphi_v^t(x^t, y^t) / \varphi_v^{t+1}(x^{t+1}, y^{t+1})}$$

$$= \left[\frac{\varphi_v^{t+1}\left(x^{t+1}, y^{t+1}\right)}{\varphi_v^B(x^{t+1}, y^{t+1})} \times \frac{\varphi_v^B\left(x^t, y^t\right)}{\varphi_v^t(x^t, y^t)}\right]. \tag{4}$$

The BSC which is the last component of the three-factor model of BMPI could be expressed as follows:

$$BSC = \frac{BMPI_c}{BMPI_v} = \frac{\varphi_c^B\left(x^t, y^t\right) / \varphi_v^B\left(x^t, y^t\right)}{\varphi_c^B(x^{t+1}, y^{t+1}) / \varphi_v^B(x^{t+1}, y^{t+1})}$$

$$= \left[\frac{\varphi_c^B\left(x^t, y^t\right)}{\varphi_v^B(x^t, y^t)} \times \frac{\varphi_v^B\left(x^{t+1}, y^{t+1}\right)}{\varphi_c^B(x^{t+1}, y^{t+1})}\right], \tag{5}$$

where, $BMPI_c/BMPI_v$ the ratio of the BMPI of constant and VRS.

Thus, merging Equations (3)–(5), the three-factor component of BMPI of Pastor *et al.* (2011), is as follows:

$$\mathrm{BMPI}_c\left(x^t, y^t, x^{t+1}, y^{t+1}\right) = \left[\frac{\varphi_v^t\left(x^t, y^t\right)}{\varphi_v^{t+1}(x^{t+1}, y^{t+1})}\right] \times \left[\frac{\varphi_v^{t+1}\left(x^{t+1}, y^{t+1}\right)}{\varphi_v^B(x^{t+1}, y^{t+1})} \times \frac{\varphi_v^B\left(x^t, y^t\right)}{\varphi_v^t(x^t, y^t)}\right] \times \left[\frac{\varphi_c^B\left(x^t, y^t\right)}{\varphi_v^B(x^t, y^t)} \times \frac{\varphi_v^B\left(x^{t+1}, y^{t+1}\right)}{\varphi_c^B(x^{t+1}, y^{t+1})}\right]. \quad (6)$$

The intermediation approach by Sealey and Lindley (1977) was adopted for this study. The approach views banks as intermediaries that channel surplus units' funds in the form of deposits to deficit units as loans and other interest earning investments (Berger and Humphrey, 1997). The production approach, on the contrary, views banks as production units that render services to their clients by receiving deposits and processing loans. On the choice of approach, however, no conclusion has been drawn in input-output variable classification for efficiency and productivity analysis (Sathye, 2001). Consequently, the current study uses three inputs of deposits, labor and physical capital and two outputs, namely, loans and advances and other earnings assets (investments) in estimating bank productivity in Africa. Table III outlines the summary of the inputs and outputs used for the first stage analysis of bank productivity in Africa.

4.2 Modeling determinants of bank productivity

Many DEA studies have weighed up the impact of environmental covariates on efficiency and productivity estimates. This is usually completed through a two-stage process whereby efficiency and productivity estimates obtained in the first stage analysis are regressed on certain covariates in the second stage. However, there is ongoing debate about the appropriate model to use in the second stage. Most of the earlier studies used either OLS or Tobit regression techniques. Simar and Wilson (2007, 2011) argued that the use of these techniques become challenging since DEA scores are bounded between 0 and 1 (Ataullah and Le, 2006). Hence, they proposed a truncated bootstrapped approach for the second stage regression. On the other hand, Banker and Natarajan (2008), as well as Hoff (2007), and McDonald (2009) argued that OLS provides consistent estimates in the second stage regression. Indeed, very recently, Banker *et al.* (2019) have shown that the simple two-stage DEA + OLS model, and to a lesser extent the DEA + Tobit method significantly outperform the more complex Simar–Wilson's DEA + Bootstrapped truncated model, in the presence of noise.

Variables	Definition	Description	Reference
Inputs			
*X*1	Deposits	Total deposits from customers	Erasmus and Makina (2014) and Alhassan and Ohene-Asare (2016)
*X*2	Labor	Total personnel expenses	Alhassan and Biekpe (2016) and Maredza and Ikhide (2013)
*X*3	Physical capital	Fixed assets (PPE) from the balance sheet	Alhassan and Ohene-Asare (2016)
Outputs			
*Y*1	Loans and advances	Total loans and advances offered to customers	Murillo-Melchor *et al.* (2009) and Maredza and Ikhide (2013)
*Y*2	Other earnings assets	Securities investment	Murillo-Melchor *et al.* (2009)

Source: Compiled by authors (2017)

Table III. Definitions of the inputs and outputs variables

In view of the prevailing controversy, we use all three approaches in examining the effects of environmental factors on the productivity estimates. In model (7) below, banks' total productivity changes are regressed on some bank-specific, industry and macroeconomic variables, using OLS, Tobit model and the truncated bootstrapped regression. Model (8) analyses how foreign productivity affects African bank productivity by classifying foreign banks into Europe, Asia and USA.

Bank total factor productivity:

$$\mathrm{BMPI}_{it} = \alpha + \sum_{j=1}^{11} \beta_j X_{it} + \varepsilon_{it}. \tag{7}$$

Foreign ownership (above 50 percent ownership) and domestic productivity:

$$\mathrm{BMPI}_{it} = \alpha + \sum_{j=1}^{11} \beta_j X_{it} + \beta_{12}\mathrm{EURO}_{it} + \beta_{13}\mathrm{ASIA}_{it} + \varepsilon_{it}, \tag{8}$$

where, X is the set of determinants; STAT the state ownership (dummy); FOR the foreign ownership (reference); PRIV the private ownership (dummy); CDUA the CEO duality ($1 =$ dual; $0 =$ otherwise); NED the proportion of non-executive directors; ASIA the foreign banks from Asia (dummy); EURO the foreign banks from Europe; AMER the foreign banks from USA (reference); SIZE the bank size; CRISK the credit risk; MQUA the management quality; GDPC the GDP per capita; LEV the leverage; HHIL the bank concentration; EXRATE the exchange rate; ε_{it} the idiosyncratic error; i and t the individual bank level and country effect and time effect, respectively.

CDUA describes a situation where the board chairman is the same as the Chief Executive Officer of the bank. The current study expects a negative relationship with productivity, in line with the results of most studies (Liang *et al.*, 2013). NED is the ratio of outside directors to the total board size. The presence on the board is primarily to monitor the inside managers and ensure that executive directors are aligning policies with shareholders' interests (Fama, 1980). Findings of preceding studies asserted a higher efficiency when the proportion of NEDs is high (Liang *et al.*, 2013). Therefore, the current study expects a positive relationship with productivity.

Bank size (SIZE) is estimated using the natural logarithm of the bank's asset size. Size is introduced to determine if there is possibility of economies or diseconomies of scale existing in Africa's banking industry. Research studies conducted on efficiency and productivity and bank size have been inconclusive. Bank credit risk (CRISK) represents the ratio of loan loss reserves to total loans. Alhassan and Biekpe (2016) reported a negative relationship with productivity. Similarly, we expect a negative relationship with productivity.

Leverage (LEV) is computed as the ratio of the total debt to total assets. Whiles an increase of leverage leads to potential bankruptcy and deprivation from profitable investments, it reduces agency costs of free cash flows by preventing investments in non-positive net present value projects (Akbar *et al.*, 2016). Alhassan and Ohene-Asare (2016) found a negative association existing between leverage and productivity. This study expects a similar situation. The ratio of non-interest expenses to total assets is used as a proxy for management quality (MQUA). The extent to which management are able to curb expenses other than expenses incurred from traditional activities contributes to productivity. With reference to Sufian (2009), the current study also expects an inverse relationship with productivity.

GDP per capita (GDPC) refers to the ratio of the total output to the number of persons in an economy. This study expects a positive relationship with productivity. Exchange rate

(EXRATE) refers to the worth of a country's currency with respect to other countries' currency. Depreciation in the value of the local currency demotivates investors from engaging in importation activities. This is because per unit cost of imported goods and services increases. This decreases productivity. On the other hand, depreciation of the local currency encourages exportation and raises revenue in the local market. Therefore, this contributes to productivity. Following from above, the current study expects either a positive or negative relationship between exchange rate and productivity. HHIL is the Herfindahl–Hirshman Index, and is used to assess the effect of market concentration on bank productivity.

In this study, three sources of foreign ownership are identified. These are banks originating from Europe and Asia, treated as dummies with American banks as the reference category. According to Sufian (2009), banks from Europe had a significant negative effect on Malaysian banking system. However, considering their comparative advantages of technology, it is expected that these banks impact positively on productivity.

4.3 Sampling and data sources

A balanced panel data of 120 banks representing 24 African countries was used for the study. Extensive data covering a much longer period, and including more recent years would have been ideal for the study. However, due to inaccessibility of the full complement of data, the period covered is 2007–2012. The groupings of the countries are done according to the four fixed geographic locations. Data for input and output variables used in evaluating productivity, as well as ownership structure and bank-specific variables are sourced from Bankscope and annual reports of banks on their websites. The macroeconomic variables are sourced from World Development Indicators.

5. Empirical results

5.1 Descriptive statistics and correlation of input and output variables

Table IV reports the descriptive statistics of the input and output variables across ownership and regions. Table V also presents a correlation matrix of all inputs and outputs used for the study. One sufficient prerequisite prior to estimating efficiency or productivity in DEA is testing whether there is strong positive correlation between the input and output variables. The isotonicity test is passed when this condition is met (Thanassoulis, 2001). This condition implies an output should increase with an increase in input (Wanke *et al.*, 2015). Since there is a significantly positive association with both inputs and outputs, the isotonicity property is satisfied.

5.2 Dynamic productivity in Africa

The main focus of the study is to assess the growth in productivity using the biennial Malmquist approach. The main purpose is to know whether banks in Africa recorded productivity growth, stagnation or retrogression. Table VI shows the summarized results of the total factor productivity change. BMPI represents yearly average dynamic productivity scores. Since DEA efficiency estimates are benchmark estimates, to summarize the average of the biennial productivity indices, the geometric mean is preferred to arithmetic mean because the scores are percentages. Overall, on the average, banks in Africa experienced approximately 2 percent ([0.980792−1]× 100) decline in productivity. This decline was also evident in year-on-year changes. There is observation of marginal improvement; however, this was below optimality. The possibly high banking transaction costs, high overhead costs, high margins, inefficiencies and low competition (high concentration) could be a possible reason for the low productivity growth (Doku *et al.*, 2013).

	Inputs			Outputs	
	Fixed asset (in $ millions)	Personnel expenses (in $ millions)	Deposits (in $ millions)	Loans and advances (in $ millions)	Total securities (in $ millions)
Pooled					
Mean	52.28104	65.515	2,780.18	2,727.978	881.53
Max.	1,245	1,840	84,050	76,371	40,314
Min.	0.004	1	17	3	0.001
SD	162.2049	241.7715	10,601.08	11,173.8	3,931.988
n	600	600	600	600	600
Ownership					
State					
Mean	42.59	33.59	1,527.05	959.25	333.36
Max.	218	146	10,737	6,324	2,082
Min.	1	1	40	19	0
SD	58.96	38.85	2,526.24	1,399.24	464.18
n	75	75	75	75	75
Private					
Mean	87.99	114.7	5,106.86	5,059.75	1,789.25
Max.	1,245	1,840	84,050	73,590	40,314
Min.	0.1	1	17	5	0
SD	228.39	338.53	15,484.5	15,313.38	6,022.85
n	220	220	220	220	220
Foreign					
Mean	28.91	37.89	1,410.07	1,480.97	361.58
Max.	1,054	1,634	56,192	76,374	19,514
Min.	0	1	26	3	1
SD	109.2	171.7	6,400.62	8,386.63	1,826.78
n	305	305	305	305	305
Group					
F-stat	8.859***	7.35***	8.582***	7.803***	9.521***
Region					
North Africa					
Mean	51.51	33.46	2,561.74	1,410.66	457.66
Max.	218	146	10,737	6,324	2,082
Min.	3	3	150	76	1
SD	60.54	35.43	3,103.67	1,467.56	579.73
n	35	35	35	35	35
West Africa					
Mean	43.51	26.06	898.44	646.26	297.63
Max.	427	217	7,738	5,141	4,054
Min.	2	2	20	10	2
SD	87.46	38.06	1,499.06	1,075.07	653.81
n	105	105	105	105	105
East Africa					
Mean	16.22	15.75	443.39	326.95	119.66
Max.	105	140	3,349	2,565	1,038
Min.	0	1	17	17	0
SD	22.48	23.07	533.39	414.97	159.86
n	250	250	250	250	250
Southern Africa					
Mean	99.72	149.83	6,539.35	6,846.76	2,151.11

(*continued*)

Table IV. Descriptive statistics of variables used to assess productivity

	Inputs			Outputs	
	Fixed asset (in $ millions)	Personnel expenses (in $ millions)	Deposits (in $ millions)	Loans and advances (in $ millions)	Total securities (in $ millions)
Max.	1,245	1,840	84,050	76,374	40,314
Min.	0	1	26	3	1
SD	257.97	393.59	177,220.64	18,174.02	6,441.84
n	210	210	210	210	210
Group					
F-stat	10.7***	14.04***	14.93***	15.83***	11.96***

Table IV.

Note: ***Significant at the 1 percent level

	Fixed assets	Personnel expenses	Total customer deposits	Loans and advances	Total securities
Fixed assets	1				
Personnel expenses	0.97***	1			
Total customer deposits	0.93***	0.97***	1		
Loans and advances	0.94***	0.98***	0.98	1	
Total securities	0.85***	0.89***	0.93***	0.90***	1

Table V.
Correlation matrix of inputs and outputs

Notes: $n = 600$. ***Significant at the 1 percent level

Period	BMPI all banks	BMPI state	BMPI private	BMPI foreign
2007–2008	0.969444	1.004006	0.967141	0.962779
2008–2009	0.969509	0.91919	0.944099	1.001298
2009–2010	0.989493	1.023967	0.963856	0.999951
2010–2011	0.985145	0.972789	0.98633	0.987352
2011–2012	0.990595	1.129847	0.947194	0.990568
Geometric mean	0.980792	1.007612	0.961604	0.988291

Table VI.
Total factor productivity in Africa and among the ownership structures

Source: Compiled by authors (2017)

Among the ownership structures, interestingly, state banks in the sample over the period under consideration were more productive than private and foreign banks. State banks recorded a marginal 1 percent ([1.007612−1]×100) increase in productivity on average, whereas foreign banks and private banks experienced approximately 1 and 4 percent productivity regress. The current finding is contrary to the results of Isik (2007) who argued lower productivity of state banks as against their peers. However, it is in line with Zaim (1995) and Das and Kumbhakar (2012) who found that state-owned banks performed better than private and foreign banks in terms of efficiency. Possible reasons why state banks may perform better than private and foreign banks may include, high fee income from undertaking most of the government borrowing programs, implicit government guarantee of state banks, recapitalization support from government and efforts to enhance financial inclusion in pursuit of social objectives (Das and Kumbhakar, 2012).

In an attempt to find the differences among the regional blocks, Table VII highlights the variations in growth over the sample period. On average, West Africa grew by 2 percent [(1.023811−1)×100], North Africa showed approximately no progress [(0.997546−1)×100]

followed by Southern Africa with 3 percent decline ([0.97055−1]×100) and East Africa with 4 percent decrease [(0.959521−1)×100] in total factor productivity. Possible reasons could be the differences in competition and entry regulations. Even though North and Southern Africa have more developed and matured systems than West Africa, it is relatively easier for new banks to enter the West African banking industry (Nyantakyi and Sy, 2015). The low growth recorded by banks in East Africa could be attributed more to the high patronage of informal mobile money system (M-PESA) to the formal banking where clients deposit funds into bank accounts and own ATM cards to access monies. This is supported by the descriptive statistics of input and output variables in Table IV, with the region recording the least deposits relative to the other regions. Moreover, most of the East African countries in the sample do not have well-established stock markets, thereby making it difficult investing in the domestic market (Allen *et al.*, 2011).

In order to address the source of total factor productivity, the biennial Malmquist index is decomposed into the EC, TC and SC. From Table VIII, technological change reduced productivity by 3 percent approximate [(0.973582−1)×100] with SC recording the highest by a marginal increase of 1.4 percent [(1.01446−1)×100] across the period. In other words, the size of the industry (the scale of operations) and managements' decision-making contributed significantly to productivity. The size of technology was the main cause of the decline in the general productivity. Due to the rather high negative contribution from technology, the weighted impact of the three sources still resulted in general decline.

Table IX presents sources of productivity among ownership. Both state and foreign banks could attribute their growth to changes in managerial competence and size of operation. For private banks, however, their low productivity stems from EC and TC. State and foreign banks grew in EC by 2 percent whereas private banks fell by about 1 percent. For TC, none of the ownership structures exhibited growth. However, the closeness to optimality showed improvement in state banks, followed by foreign banks and finally private banks. Private banks rather proved to be productive in scale as they grew by 2 percent while state-owned and foreign banks each followed suit with about 1 percent increase.

Period	Africa	North Africa	West Africa	East Africa	Southern Africa
2007–2008	0.969444	0.980647	0.99454	0.980431	0.947529
2008–2009	0.969509	0.935793	1.069428	0.920104	0.98203
2009–2010	0.989493	1.044854	1.046103	1.021502	0.916827
2010–2011	0.985145	1.007801	1.064975	0.86179	1.090971
2011–2012	0.990595	1.022215	0.949319	1.024184	0.925278
Geometric mean scores	0.980792	0.997546	1.023811	0.959521	0.97055

Source: Compiled by authors (2017)

Table VII. Productivity among the regional blocs

Period	EC	TC	SC
2007–2008	1.15326	0.840607	1.009127
2008–2009	1.023289	0.947446	1.025546
2009–2010	0.919816	1.07575	1.019612
2010–2011	0.926963	1.062771	1.000452
2011–2012	1.031174	0.960647	1.017755
Geometric mean scores	1.007405	0.973582	1.01446

Source: Compiled by authors (2017)

Table VIII. Changes in efficiency, technology and scale across Africa

Year	EC	TC	SC
State			
2007–2008	1.158779	0.866416	0.964706
2008–2009	0.954877	0.962632	1.050199
2009–2010	0.916863	1.116828	1.026899
2010–2011	0.913349	1.065066	0.9811
2011–2012	1.163017	0.971476	1.030334
Geometric mean	1.015068	0.99265	1.01013
Private			
2007–2008	1.129057	0.856595	1.025686
2008–2009	1.00486	0.939524	1.04378
2009–2010	0.892515	1.079936	1.068105
2010–2011	0.943975	1.044888	0.987216
2011–2012	1.011364	0.936549	1.022084
Geometric mean	0.993256	0.968136	1.029028
Foreign			
2007–2008	1.169666	0.823116	1.008451
2008–2009	1.054583	0.949482	1.006694
2009–2010	0.940768	1.0629	0.984281
2010–2011	0.918217	1.07529	1.014972
2011–2012	1.015217	0.975721	1.011584
Geometric mean	1.015841	0.972878	1.005137

Source: Compiled by authors (2017)

Table IX. Changes in efficiency, technology and scale among ownership

Table X provides an analysis within regions to identify the driving force of productivity. West Africa's highest growth could be attributable to 6 percent growth in efficiency (EC). Although the other regions were below optimal productivity, Southern Africa and East Africa were productive in scale (SC) whereas EC contributed positively to North Africa. The results indicate that for EC, West Africa and North Africa recorded 6 and 1 percent growth, respectively, and East Africa and Southern Africa also showed 1 and 2 percent pure efficiency regress accordingly. For TC, all the regions regressed in growth over the entire period. In spite of that, North Africa, Southern Africa, West Africa and East Africa in that order showed closeness to optimal productivity. Finally, with the exception of a decline of 1 percent from North Africa, the SC results indicate the highest growth from West Africa (2.2 percent), followed by East Africa (2.1 percent) and Southern Africa (1.2 percent) accordingly.

5.3 Multivariate analysis

The study assumed a common frontier for domestic (state and private) and foreign banks. This may be questionable considering the differences that exist in their legal and business environment and priorities (Sufian, 2011). Therefore, the study adapts to procedures outlined in Sufian and Kamarudin (2014) and Isik and Hassan (2002) among others, to test whether frontiers are identical among the ownership structures and regional blocks. To achieve this, both the parametric ANOVA *F*-test and non-parametric Kruskal–Wallis test are employed. State, private and foreign banks were compared among the means and medians of the overall productivity and individual components of the productivity as presented in Table XI. Although private banks were least productive (4 percent fall) compared to state banks (1 percent growth) and foreign banks (1 percent fall), they were comparatively able to manage their size of operations better than state banks and foreign banks. Also, whereas foreign banks proved to be better in efficiently using managerial

Year	EC	TC	SC
North Africa			
2007–2008	1.124862	0.871785	0.900315
2008–2009	1.025528	0.912485	1.015941
2009–2010	0.933451	1.119356	1.066134
2010–2011	0.991855	1.016087	0.99957
2011–2012	0.981286	1.041683	0.969185
Geometric mean	1.00943	0.988221	0.988687
West Africa			
2007–2008	1.21041	0.821666	1.039911
2008–2009	1.161887	0.920436	0.996416
2009–2010	0.981964	1.065322	1.055733
2010–2011	0.96053	1.108743	0.995403
2011–2012	1.012421	0.937696	1.023937
Geometric mean	1.060749	0.965189	1.022004
East Africa			
2007–2008	1.170131	0.837877	0.999585
2008–2009	0.989003	0.930337	1.052007
2009–2010	0.953567	1.071233	1.029155
2010–2011	0.829779	1.038582	0.987954
2011–2012	1.075597	0.952195	1.038902
Geometric mean	0.996963	0.962442	1.021236
Southern Africa			
2007–2008	1.097161	0.863606	1.030008
2008–2009	1.011312	0.971046	1.01851
2009–2010	0.857173	1.069594	0.986593
2010–2011	1.031442	1.057717	1.021898
2011–2012	0.958385	0.965456	1.00118
Geometric mean	0.987738	0.982597	1.011516

Source: Compiled by authors (2017)

Table X. Changes in efficiency, technology and scale among regional blocs

	BMP	EC	TC	SC
Ownership				
State	1.01 (1)	1.02 (1)	0.99 (1.01)	1.01 (1)
Private	0.96 (1)	0.99 (1)	0.97 (1)	1.03 (1.01)
Foreign	0.99 (1)	1.02 (1)	0.97 (1)	1.01 (1)
ANOVA (*F*-test)	1.475	0.836	0.593	1.797
Kruskal–Wallis	1.7445	0.23643	1.4151	9.0601**
Regions				
North	1.00 (0.99)	1.01 (1)	0.99 (1.03)	0.99 (0.99)
West	1.02 (1.01)	1.06 (1.01)	0.97 (1)	1.02 (1)
East	0.96 (1)	1.00 (1)	0.96 (1)	1.02 (1)
South	0.97 (1)	0.99 (1)	0.98 (1)	1.01 (1)
ANOVA (*F*-test)	1.437	1.67	0.616	0.475
Kruskal–Wallis	5.0255	3.1019	2.2746	5.2654

Notes: Average Mean (Median); **Significant at the 5 percent level

Table XI. Dynamic productivity comparisons

competence among its peers, state banks were better in controlling production process and taking advantage of technological innovation than its peers. Statistically, however, the differences were insignificant. Again, in spite of the statistical differences for SC, the pairwise differences using Tukey HSD and the kernel density plots remained

insignificant across state, private and foreign banks. This is, however, not reported in order to conserve space.

Also, in comparing regions, although West Africa recorded the highest growth of 2 percent compared to the other regions, the same analysis cannot be observed among the technological component of productivity. Whereas North Africa are comparatively better able to take advantage of changes in technology than the other three regions, West Africa were better able to take advantage of the managerial acumen and manage size of operation. The differences, however, were not statistically significant as reported in Table XI.

5.4 Regression analysis

Table XII briefly describes the variables used in the regression analysis. From the correlation matrix displayed in Table XIII, there is no sign of multicollinearity as the coefficients of the pairwise variates are less than 50 percent.

Three models, OLS, Tobit and truncated bootstrapped regressions were estimated. The results are largely consistent across the three models. As observed in Table XIV, it is apparent that the coefficients of both state and private ownership were not statistically significant in any of the models. This comes as a surprise as most results reported in extant literature suggest that ownership impacts bank performance. However, Barth *et al.* (2004) have shown that cross-country differences in regulatory and supervisory characteristics such as capital regulations, official supervisory practices, incentives for private monitoring and restrictions on bank entry and activities could lead to such insignificant results. Both CDUA and NED show positive signs, but only NED is statistically significant in the OLS and Tobit models. This is in line with Liang *et al.* (2013). Outside directors are more likely to exercise independent control over management, thereby ensuring higher productivity.

Bank size is insignificant in determining banks' total factor productivity per the OLS and truncated regression findings. However, leverage was found to be positive and significant in the OLS and Tobit models and supports similar results in Sufian (2009). The positive coefficient suggests that leverage plays an important role in the potential of unproductive banks to recover and grow faster and gain market power. Ceteris paribus, productive banks opt for debt financing over equity financing. A probable reason could be that more productive banks resort to debt to finance riskier projects, thereby enjoying the cost and tax savings associated with debt financing.

	Count	Mean	Median	SD	Minimum	Maximum
BMPI	600	1.020797	1	0.32643	0.1984	4.4768
STAT.DUMMY	600	0.125	0	0.330995	0	1
PRIV.DUMMY	600	0.366667	0	0.482296	0	1
CDUA	600	0.016667	0	0.128126	0	1
NED	600	0.142168	0	0.234761	0	0.9
SIZE	600	6.357568	6.207583	1.592399	3.367296	11.74981
LEV	600	0.869744	0.883094	0.062779	0.575472	0.979142
MQUA	600	0.032995	0.030541	0.019807	0	0.109756
CRISK	600	4.201667	2.72	4.317628	0	27.73
HHIL	600	0.292486	0.212879	0.233714	0.029104	1
GDPC	600	6.897782	6.403934	1.067294	5.325062	8.809478
EXRATE	600	4.499624	4.372395	2.469451	0.056246	8.546218
EUROPE.DUMMY	600	0.216667	0	0.412317	0	1
ASIA.DUMMY	600	0.025	0	0.156255	0	1

Table XII.
Summary statistics of regression variables

Source: Compiled by authors (2017)

Table XIII. Correlation matrix of variables used regression

	BMP	STAT. DUMMY	PRIV. DUMMY	CDUA	NED	SIZE	LEV	MQUA	CRISK	HHIL	GDPC	EXRATE
BMP	1.0000											
STAT.DUMMY	0.0216	1.0000										
PRIV.DUMMY	−0.0701*	−0.2876***	1.0000									
CDUA	0.0354	0.1476***	−0.0991**	1.0000								
NED	0.0774*	−0.1933***	−0.0492	−0.0789*	1.0000							
SIZE	0.0210	0.0403	−0.0054	0.0096	0.2313***	1.0000						
LEV	0.0588	−0.0359	−0.1799***	0.0336	0.0549	0.2990***	1.0000					
MQUA	−0.0658	−0.0215	0.2472***	0.0718*	0.1098***	−0.0648	0.0286	1.0000				
CRISK	0.0566	0.0450	0.0128	0.1451***	−0.0245	−0.0635	−0.1495***	−0.0756*	1.0000			
HHIL	−0.0597	−0.0034	−0.0539	0.0180	−0.1423***	0.0416	0.0005	−0.2592***	0.2554***	1.0000		
GDPC	0.0535	−0.0436	−0.0256	−0.0627	0.2088***	0.4856***	0.2150***	0.1740***	−0.0963**	0.0520	1.0000	
EXRATE	−0.1089***	−0.0361	−0.0638	−0.0653	−0.1279***	−0.3563***	−0.0244	−0.2800***	0.0750*	−0.0478	−0.4132***	1.0000

Notes: *,**,***Significance at the 10, 5 and 1 percent levels, respectively

Dependent variable: BMPI	OLS	Tobit	Truncated
STAT.DUMMY	0.0148 (0.0375)	0.0245 (0.0665)	−0.0188 (0.0419)
PRIV.DUMMY	−0.0094 (0.0268)	−0.0314 (0.0486)	−0.0550 (0.0353)
CDUA	0.0698 (0.0770)	0.1494 (0.1497)	0.1011 (0.0702)
NED	0.1358* (0.0728)	0.1675* (0.0957)	0.0443 (0.0825)
SIZE	−0.0215) (0.0177)	−0.0533*** (0.0169)	−0.0168 (0.0168)
LEV	0.4702* (0.2614)	0.8263** (0.3696)	0.4421 (0.2757)
MQUA	−2.3730*** (0.9080)	−3.6791*** (0.2083)	−2.5579*** (0.9707)
CRISK	0.0078* (0.0040)	0.0110** (0.0051)	0.0072** (0.0041)
HHIL	−0.1647*** (0.0539)	−0.2398** (0.0960)	−0.1819*** (0.0563)
GDPC	0.1064*** (0.0368)	0.1372 (0.0696)	0.0112 (0.0231)
EXRATE	−0.0000*** (0.0000)	−0.0000** (0.0000)	−0.0220*** (0.0095)
EUROPE.DUMMY	−0.1854*** (0.0630)	−0.3226** (0.1378)	−0.0799** (0.0429)
ASIA.DUMMY	0.0428 (0.0473)	0.0008 (0.0765)	−0.0922 (0.1020)
(Constant)	0.1427 (0.3056)	0.0245 (0.0665)	0.8983*** (0.2260)
Observations	598	598	598
F-statistic	2.64***		
R^2	0.06		
σ			0.3173*** (0.0337)
Log-likelihood		−344.39	−159.34

Table XIV.
Regression results

Notes: Robust standard errors in parenthesis. *,**,***Significant at 10, 5 and 1 percent levels, respectively

Management quality showed a significant negative relationship with dynamic productivity in all the models, which is consistent with results by Sufian (2009). The active involvement of management in the day-to-day activities contributes in shaping decisions made for companies. They are to ensure efficient use of inputs to produce optimal output and profits. The findings seem to suggest poor management practices in input usage, especially in operational management and loan portfolio management, as well as costs emanating from non-interest sources.

However, contrary to the findings of Maredza and Ikhide (2013) and Sufian (2009), the coefficient of the ratio of loan loss reserve to gross loans, an indicator for bank credit risk reported a significant positive relationship in all the three models. Banks that make risky loans may be obliged to hold a higher amount of provisions. And in order to compensate for the higher risk of default, they may charge higher margins, leading to a positive relationship (Maudos and de Guevara, 2004).

Again, market concentration yields a significant inverse relationship with productivity change of banks in all the estimations, which resonates with Alhassan and Biekpe (2016). This suggests that productivity may decline when banking markets are concentrated. This is in line with the "quiet-life" hypothesis of Hicks (1935), who asserts that concentration enables firms to enjoy monopoly rents, thus giving managers no incentive to be productive. The negative relationship between concentration and productivity also reflects the significant role of competition in product development and innovation in banking markets (Alhassan and Biekpe, 2016). This also means that competition is stifled in African banking industries with high concentration. For instance, the northern and southern African countries experience tightened regulatory entry into the banking industry; with market capitalization concentrated in the hands of a few giant companies, mostly state and foreign banks. This results in inefficient/costly production and poor quality of service, thereby reducing overall productivity in the long run.

GDP per capita is positive, but significant only in the OLS model. Also, there was a negative significant relationship between exchange rate and bank productivity across the three models. A plausible reason is that the high cost of production from the depreciation of

local currencies against the dollar results in decreasing productivity. Many African countries struggle with high levels of currency depreciation which has implications for bank asset values and performance of local firms who provide business to banks.

To provide further insight, the origin of foreign banks in Africa is included in the models to assess overall productivity for banks in Africa. This prevents generalization made of foreign bank productivity which could lead to biased conclusions (Sufian, 2009). By origin, the study identifies the parents' continents. Since African banking industry is the main focus, foreign banks whose parent companies are in Africa are excluded from the regression. Foreign banks operating in Africa are put into three major groups and treated as dummies – Europe, Asia and America (as reference).

The empirical findings suggest that foreign banks from Europe are likely to be less productive compared to foreign banks from America. The study affirms the findings in Sufian (2011). However, Asian banks were statistically insignificant to productivity. Accordingly, the home field advantage hypothesis by Berger *et al.* (2000) is partially supported since the indigenous banks have a comparative advantage due to the cost associated with "liability of foreignness" (Miller and Parkhe, 2002) of the foreign banks.

6. Conclusions and policy implications

The study mainly sought to estimate changes in productivity in banks in Africa using the biennial Malmquist index and bank level data across 24 African countries from 2007 to 2012. The scores were analyzed among ownership structure and regions to appreciate how far they have grown over the study period. Bank-specific, industry and macroeconomic variables are regressed on bank productivity scores. However, in view of the prevailing controversy surrounding the appropriate model to use in a second stage regression involving productivity estimates, we use all three models most commonly used in the literature, OLS, Tobit and truncated bootstrapped regression. Finally, to assess how foreign banks influence the African banking industry, foreign banks are grouped based on their place of origin – Europe, Asia and USA. This was to test the home field advantage and global advantage hypotheses.

An overall conclusion is that productivity of banks in Africa declined for the period under study. The level of technology was the main contributory factor to the African banks' productivity decline. Even though private banks were the most efficient among its peers, they showed the least growth in overall productivity. Also, North African banks were stagnant in productivity (0 percent growth) overtime; only West Africa showed progress in productivity. This suggests that not all banks that are efficient are necessarily productive.

The regression results were largely consistent across the three models. Environmental factors including NED, management quality, leverage, bank credit risk, market concentration and exchange rate have significant impact on bank productivity. However, ownership and CDUA are irrelevant to bank productivity. In comparison with domestic banks, foreign banks did not succeed in capitalizing on their advantages thereby exhibiting no productivity gains. Moreover, banks from Europe proved to impact more negatively on overall productivity than Asian and American banks. Therefore, the empirical analysis partially supports the home field advantage hypothesis.

From the findings and conclusions of the study, bank management is advised to constantly invest in state-of-the-art technology, and to be innovative in improving their resource allocation to produce optimal outputs in the long run. The findings seem to suggest poor management practices in input usage, especially in operational management, as well as costs emanating from non-interest sources. Bank managers need to address these deficiencies to improve productivity in African banking markets. Also, regardless of size, they are to ensure proper cost management. This is to boost technological efficiencies overtime. Again, the human capital must be trained to utilize and be proficient in the ever

evolving demands in technology for a boost in productivity, to promote managerial efficiencies overtime. From the regulatory perspective, governments and regulatory bodies should enact strategic policies to stabilize the local currency and create enabling environment to boost local/domestic banking and promote local investments. One possible way is by lowering tax rates and other fiscal benefits to local start-up banks in order to fairly compete with their peers. Also, improving the competitiveness of the banking markets will enhance productivity. Given the negative effect of high concentration on competition, it is evident that further loosening of the tight regulatory regimes in some countries is warranted, in order to avoid inefficient production and poor quality of service, thereby increasing overall productivity. Future research could look into more detailed analysis of corporate governance such as inside ownership and concentrated ownership to appreciate the impact of these on productivity. Also, the productivity obtained in African banking industry could be compared with other developing and transition economies.

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About the authors

Sarah Beatson Nartey holds MPhil Degree in Finance from the University of Ghana Business School. Her areas of research interests include ownership structure, corporate governance and bank performance.

Kofi A. Osei is Associate Professor of Finance at the University of Ghana Business School. His areas of research interests include emerging stock markets, capital market efficiency and international financial markets. He has published in international journals including the *South African Journal of Economics*, *Journal of Economic Studies*, *International Journal of Social Economics*, *Journal of Risk Finance* and *African Finance Journal*.

Dr Emmanuel Sarpong-Kumankoma is Senior Lecturer in Finance at the University of Ghana Business School. His research interests include market structure and bank performance. He has publications in journals such as *Journal of Property Research*, *Journal of Economic Studies*, *International Journal of Law and Management*, *African Journal of Economic and Management Studies* and *Journal of Financial Regulations and Compliance*. Dr Emmanuel Sarpong-Kumankoma is the corresponding author and can be contacted at: esarpong-kumankoma@ug.edu.gh