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Abstract

Using a two-step system generalized method of moment (GMM) technique and a panel data for 43 sub-Sahara African countries from 1998 to 2012, this article examines the drivers of energy intensity. Specifically, the article tests two hypotheses: (1) improved banking performance does not foster energy efficiency improvements, and (2) institutional quality (democracy) does not compromise the energy-saving role of improved banking performance. The study uses a unique bank-based data by Andrianova et al. (2015) and different indicators of bank performance- return on asset, asset quality, bank capitalization, managerial inefficiency and financial stability. The paper also constructs a composite bank performance index from these indicators using the principal component analysis. The results reveal that, both in the short and long run, improved banking performance foster energy efficiency improvements in sub-Saharan Africa, but this is compromised by democracy (institutional quality). Thus, to achieve energy efficiency improvements, specific initiatives should be implemented to boost development of the banking sector while also ensuring that democratic governments in the sub-region wean themselves off things that impede the progress of the real sector. More ambitiously, creating a Green Bank may be necessary to stimulate energy efficiency investments in the sub-region.

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1 Introduction

Economic growth in sub-Saharan Africa has been encouraging. However, the poor energy situation in the region poses a significant risk for future economic growth. While energy supply has progressed slowly, demand for energy continues to surge driven mainly by economic growth and demographic patterns. This imbalance in demand and supply has created energy security issues and caused adverse effects on the sustainability of industries and the economy at large (Adom and Amuakwa-Mensah, 2016). Sub-Saharan Africa has the lowest electricity access rate, and this has consequently increased the use of hazardous and inefficient forms of energy for cooking (International Energy Agency, 2014). Given that economic growth is likely to progress in the future[1] and drive further the growth in energy demand[2], it is essential to look at ways to minimize the use of energy without compromising economic growth. Thus, it is important to pay attention to energy efficiency enhancement in the region. Energy efficiency is one of the best cost-effective ways to reduce greenhouse gas emissions and increase energy supply security (Ang et al., 2010).

To improve energy efficiency in the region, it is very essential from the policy perspective to understand the key drivers of energy efficiency. Though several studies have investigated this problem from the African perspective by considering the roles of price, economic growth, foreign direct inflows, economic structure and economic openness (Adom and Adams, 2018; Adom and Amuakwa-Mensah, 2016; Adom, 2016, inter alia), little is known about both the direct and complementary roles of banking sector performance and the political environment on energy efficiency in the region. This in the context of sub-Saharan Africa is very important since the banking sector is the provider of finance for investment and the political institution is the regulator of government policies. As the regulator, good institution ensures the stringency of energy-efficiency policy implementation. Fredriksson et al. (2004) reveal that corruption and lobbying limit energy policy stringency. The banking sector as a provider of finance supports investment in energy-efficient equipment.

Though the banking sector in the region has improved, it is less developed when compared to other economies in Europe, Asia, America and the Caribbean (Allen et al., 2014). The less competitive nature of the banking sector has consequently resulted in the high cost of capita in the region, which has impeded investment in energy-efficient equipment. Thus, by liberalising the sector via government policy, the increase in external finance will boost domestic savings, cause decline in capital cost and induce investment in energy-efficient equipment. However, the shift to a democratic regime in the region has caused the

[1] More and more countries will grow at 3% or above per annum, with a record number of high-growth economies more than 5% per annum. Between 2001 and 2015, there were 14 such countries. This number is expected to rise to 19 by 2030. At the same time, the number of countries growing on average between 3%–4.9% per annum holds constant at 17 (EY, 2017 pp.7).

[2] Average annual growth in total energy consumption in Africa is projected to be the highest (that is, 2.6%) considering the global average of 1.4%, according to .U.S. Energy Information Administration (EIA) (2016)

emergence of strong interest or pressure groups throughout the region (Abimbola, 2002) with a less developed local content. Thus, government policies that affect the development of local content might attract opposite reactions from influential interest groups. In Zambia, the Zambian Congress of Trade Union opposed the government decision to privatize the Zambian National Commercial Bank (Ngarama and Manager, 2010). In Africa, several powerful groups exist that have reasons to delay, dilute or sabotage privatization (Nellis, 2003). For pressure groups, privatization and neoliberalism ideologies deteriorate the welfare and rights of ordinary citizen (Adalberto et al., 2006). The above suggests that, while growth of the banking sector could induce investment in energy-efficient equipment in Africa, political institution could mediate this channel due to the existence of pressure groups. However, there is no empirical study that tests this hypothesis.

Motivated by the above, this article estimates the effect of banking sector performance on an indicator of energy efficiency while considering the mediating effect of political institutions. We hypothesize that while improvement in banking performance will promote energy efficiency, the presence of political institutions that face opposition from pressure groups will moderate the energy-saving effects of bank performance. To achieve the above goal, this study uses a recently developed bank-based dataset by Andrianova et al. (2015) for sub-Saharan Africa. This paper uses several indicators of bank-based performance indicators that cover various aspect of the banks' balance sheet: return on assets, market capitalization, asset quality, managerial inefficiency and the z-score (a measure of financial fragility). Further, this article applies the Principal Component Analysis (hereafter PCA) to derive a composite index for banking performance, which is used to check for robustness. The relationship that characterizes energy efficiency and bank performance is dynamic. Further, bank performance is likely to be endogenously driven by other unobserved factors such as experience of the Chief Executive Officer, external networks, quality of workers, etc.. Based on these two concerns, this study applies the two-step System Generalised Method of Moment (GMM) to derive both short-run and long-run elasticities and to deal with the problems of simultaneity bias/endogeneity and serial correlation problems.

Following the work of Karanfil (2009), several studies have examined the link between financial development and energy consumption (Islam et al., 2013; Kakar, 2016; Komal and Abbas, 2015; Sadorsky, 2010, 2011; Shahbaz and Lean, 2012; Tamazian et al., 2009). Two main hypotheses have emerged from this study. First, *financial development increases energy consumption* (Çoban and Topcu, 2013; Komal and Abbas, 2015; Sadorsky, 2010, 2011). According to the first hypothesis, financial development can affect energy demand by providing funds for consumers to buy big ticket items (such as, air conditions, automobiles, houses, washing machines, refrigerators, etc.) which have a direct link with energy consumption (Sadorsky, 2010). Thus, the development of the financial sector causes scale effect (Karanfil, 2009; Sadorsky, 2011). Second, *financial development decreases energy consumption* (Islam et al., 2013; Shahbaz and Lean, 2012; Kakar, 2016). According to this hypothesis, development of the financial sector will facilitate technological investment and diffusion and promote the technical processes of production. Thus, financial development causes technical effects. The above suggests that the finance – energy consumption relationship is a complex one. Even though the second hypothesis connotes that financial development might promote technical effects and hence energy efficiency, in both hypotheses, no explicit examination of the link between finance – energy efficiency is established, at least in Africa, which represents an important knowledge gap in the literature. Moreover, as revealed earlier, the political environment may affect the finance – energy efficiency relationship. Few studies have linked political institutions directly to energy efficiency. Gennaioli and Tavoni (2011) reveal that rent-seeking and corruption hinder clean energy adoption. Ramos-Real et al. (2015) find that democracy promotes energy efficiency directly. However, these studies do not examine the indirect effect of political institution on the finance – energy efficiency relationships. In the case of Africa, where the growth in pressure groups is soaring, such indirect effects of political institution are likely to be stronger.

The contributions of this paper are: (1) it provides the first empirical evidence on the effect of banking performance on energy efficiency taking into account the moderating effect of political institution in the presence of pressure interest groups; (2) it uses a novel dataset by Andrianova et al. (2015) on bank performance for a panel of sub-Saharan Africa

The remainder of the study is organized as follows; section two reviews literature on the subject matter, section three discusses the method and data issues, section four presents and discusses the results, and section five provides concluding remarks.

2 Literature review

2.1 Impact of financial sector performance on energy intensity

Earlier studies on financial systems (Bencivenga and Smith, 1991; Gurley and Shaw, 1955) indicate that a well-established financial system increases the efficiency of an economy as this paves the way for proper usage of unproductive resources. Recent literature on the finance – energy relationship uses this earlier claim as a building block, by outlining different channels by which improvement of financial systems can affect energy consumption. It is asserted that through efficiency, financial development can lead to a reduction in energy consumption (Çoban and Topcu, 2013; Islam et al., 2013; Komal and Abbas, 2015). The primary argument is that improvement in the financial sector can contribute to investment in research and advanced technologies increasing competition in the market which in effect improves efficient use of energy. Also, more consumer durables such as refrigerators, microwaves, air conditioners, automobiles will be produced using these advanced technologies. As a result, users can access latest energy efficient products causing a reduction in the overall demand for energy

(Islam et al., 2013; Kakar, 2016). Mielnik and Goldemberg (2002), find a clear inverse relationship between financial development[3] and energy intensity using a sample of 20 developing countries. Tamazian et al. (2009) implicitly back this finance-energy relationship by finding that financial development lowers carbon emissions in BRICS countries implying less energy utilization in these countries.

However, there could be a direct correlation between financial development and energy use in the absence of efficiency. A well-developed financial sector lowers cost of borrowing and eases the financing process for consumers (Karanfil, 2009; Sadorsky, 2011). Easy financing process means users can easily borrow funds to purchase energy-intensive consumer goods leading to increase in energy consumption. Additionally, businesses can access financial capital at lower interest rate enabling them to obtain additional sources of finance to expand their activities. Further, expansion of firms will mean more demand for energy which in effect will increase energy consumption (Çoban and Topcu, 2013; Komal and Abbas, 2015; Sadorsky, 2011). There is vast literature supporting the positive relationship between financial development and energy consumption. Using different financial development indicators, Sadorsky (2010) also examines the impact of financial development on energy consumption in 22 emerging economies. Sadorsky (2011) repeats a similar study in 9 European countries. The findings from both studies show that financial development indicators positively affect energy consumption. A similar result is reported in the work of Shahbaz and Lean (2012) and Islam et al. (2013) in Pakistan and Malaysia, respectively.

This review suggests that there have been studies linking financial development to energy consumption via economic growth. Even though these studies implicitly acknowledge the energy efficiency-inducing effects of financial development, there are presently no (as shown in the review above), at least from the African perspective, studies that empirically investigate the question; does financial performance promote energy efficiency? The current study uses bank-based data at the country level to investigate this question.

2.2 Other determinants of energy intensity

Besides the effect of financial performance on energy intensity, several factors have been identified to have a significant effect on energy intensity. Among these factors are foreign direct investment (FDI), industrialization, urbanization, economic growth, trade openness, energy prices, infrastructure, population growth, human development, temperature and humidity. Although, empirical results show a mixed relationship between FDI and energy intensity, results show that an increase in FDI inflows has the potential to improve energy efficiency. Thus, FDI has been argued to have technologies embedded in them which eventually results in overall energy efficiency. Further, FDI inflows promote competitions which thereby compel domestic firms to adopt more energy efficient technology. Studies such as Adom (2015a, 2015b), Elliott et al. (2013), Eskeland and Har-

[3] Foreign Direct Investment is used as a proxy for financial development

rison (2003), Herrerias et al. (2013), Hübler (2011) and Zheng et al. (2011) support the energy efficiency role of FDI. However, studies such as Adom and Amuakwa-Mensah (2016), Adom and Kwakwa (2014) and Hübler and Keller (2010) observed otherwise. According to Adom and Amuakwa-Mensah (2016), the positive effect of FDI on energy intensity may be attributed to unfavourable economic and political conditions which may obstruct FDI inflows that are energy efficient.

Similarly, the evidence on the energy intensity-trade openness relationship has been mixed in the literature. Trade openness has a scale, technical and composition effects. By scale effect, trade openness stimulates economic activities and lead to an increase in energy consumption. Thus, through the scale effect, trade openness should increase energy intensity, all other things being equal. By technical effects, trade openness induces local competition, and this forces the indigenous companies to invest in energy efficiency technologies to remain competitive. Thus, through the technical effect, trade openness should decrease energy intensity. By the composition effect, the effect of trade openness will depend on the relative weights of energy consumed by exports and energy saved by imports. Thus, the overall impact of trade openness on energy intensity is not very definite. Not surprisingly, there are studies that reveal evidence of positive Adom and Kwakwa, 2014) and negative effects of trade openness (Adom, 2015a, 2015b; Adom and Amuakwa-Mensah, 2016).

The relationship between energy intensity and income is also not straightforward since both pieces of evidence of positive (Jones, 1991; Parikh and Shukla, 1995) and negative (Adom, 2016; Cole, 2006; Kepplinger et al., 2013) impacts exist. On the one hand, higher income is expected to stimulate higher use of existing energy-using appliances, while on the contrary, similar income increase can boost demand for more efficient energy appliances to replace the inefficient ones. Thus, the impact of income can be positive or negative. Motivated by this, other studies have also looked at the possible nonlinear effect of income on energy intensity. Adom (2015a), Elliott et al. (2013), and Song and Zheng (2012) have confirmed evidence of nonlinearity in the energy intensity-income relationship. In a likewise manner, the impact of urbanization on energy intensity is complicated. On the one hand, urbanization increases the demand for energy-using appliances, and this leads to higher energy use. On the other hand, the concentration of population and consumption in a small area should provide opportunities for economies of scale. Urbanization in that sense should improve energy productivity. Accordingly, both positive (Bilgili et al., 2017; Elliott et al., 2017; Ma, 2015; Sadorsky, 2013) and negative (Liddle, 2004; Poumanyvong and Kaneko, 2010; Wang, 2014) impacts exist in the literature.

The energy-saving potential of the price of energy has also received considerable attention in the literature. Generally, the results of these studies point to a negative effect of the price of energy on energy intensity (Adom, 2015a, 2015b, 2016; Birol and Keppler, 2000; Hang and Tu, 2007; Herrerias et al., 2013). In these studies, it is argued that higher energy price stimulate investment in energy efficient appliances which causes energy intensity to fall. However, this relationship may not be pronounced where government intervenes in the market by subsidizing price. In that case, price may no longer provide the incentive for energy efficiency investment, and this may cause energy intensity to increase.

There are studies that have estimated the unconditional impact of industrialization on energy intensity (see Adom and Amuakwa-Mensah, 2016; Adom and Kwakwa, 2014; Herrerias et al., 2013; Li and Lin, 2014; Poumanyvong and Kaneko, 2010). The results from these studies show that industrialization increases energy intensity. Therefore, these studies suggest, as a policy recommendation, a shift to the less energy-intensive sectors to improve energy productivity.

3 Methodology and data sources

3.1 Theoretical framework

Following the work of Adom and Amuakwa-Mensah (2016), the theoretical model used in this study is based on the neoclassical model of firm maximization of profit. The firm seeks to maximize profit by choosing the optimal level of input, which includes energy input, subject to a given level of technology. Thus, by assuming a Cobb-Douglas technology, the firm maximizes profit (as shown in equation 1) subject to the Cobb-Douglas production technology (shown in equation 2).

$$Max \longrightarrow \pi = PY - P_e E - Z \qquad \text{Profit function} \tag{1}$$

Subject to:

$$Y = AE^{\alpha} Z^{\beta} \quad \text{Production technology} \tag{2}$$

Where π, P, Y, P_e, E and Z is firm's profit, output price (this in an economic-wide sense is the rate of inflation), economic-wide output, price of energy input, energy input and composite input (whose price is normalized to one), respectively. Also, A is the knowledge accumulation (total factor productivity), and α & β indicate the respective share of energy input and composite input in total production. To solve the optimization problem, the Lagrangian equation (see equation 3) is differentiated with respect to energy (E), composite input (Z) and the Lagrangian multiplier (λ).

$$L = PY - P_e E - Z + \lambda \left[Y - AE^{\alpha} Z^{\beta} \right] \tag{3}$$

The first-order conditions for maximization are:

$$\frac{\partial L}{\partial E} = -P_e - \lambda \alpha A E^{\alpha - 1} Z^{\beta} = 0. \tag{4}$$

$$\frac{\partial L}{\partial Z} = -1 - \lambda \beta A E^{\alpha} Z^{\beta - 1} = 0 \tag{5}$$

$$\frac{\partial L}{\partial \lambda} = Y - AE^{\alpha} Z^{\beta} = 0 \tag{6}$$

Simultaneous solutions to equations 4 to 6 gives the optimal demand for energy and composite inputs required for the firm's optimal profit with a given technology. We focus on the optimal energy input requirement in this study, which is given as;

$$E = \left(\frac{\alpha}{\beta}\right)^{\frac{\alpha\beta}{\alpha\beta+1}} \left(\frac{1}{P_e}\right)^{\frac{\alpha\beta}{\alpha\beta+1}} \left(\frac{1}{A}\right)^{\frac{\alpha}{\alpha\beta+1}} Y^{\frac{\alpha}{\alpha\beta+1}} \tag{7}$$

Equation 7 shows the firm's optimal demand for energy in a perfectly competitive market. This energy demand function is inversely proportional to technology and price and increases in output. In order to derive energy intensity function, we divide both sides of equation 7 by output (Y) and this gives us Equation 8;

$$\frac{E}{Y} = \left(\frac{\alpha}{\beta}\right)^{\frac{\alpha\beta}{\alpha\beta+1}} \left(\frac{1}{P_e}\right)^{\frac{\alpha\beta}{\alpha\beta+1}} \left(\frac{1}{A}\right)^{\frac{\alpha}{\alpha\beta+1}} Y^{\frac{\alpha-(\alpha\beta+1)}{\alpha\beta+1}} \tag{8}$$

The total factor productivity (A) can be expressed as a positive exponential function of financial performance (FP), FDI, trade openness (TOP) and institutional quality (Instit) (Adom and Amuakwa-Mensah, 2016). This is depicted by Equation 9.

$$A = e^{f(\beta_2 FP+\beta_3 FDI+\beta_4 TOP+\beta_5 Instit)} \tag{9}$$

By replacing the expression of 'A' in Equation 8 by Equation 9, the energy intensity function changes to Equation 10, where EI denotes energy intensity. Thus, energy intensity, as shown in Equation 10, is a function of energy price, financial performance, income, FDIs, trade openness and institutional quality.

$$EI = \frac{E}{Y} = \left(\frac{\alpha}{\beta}\right)^{\frac{\alpha\beta}{\alpha\beta+1}} \left(\frac{1}{P_e}\right)^{\frac{\alpha\beta}{\alpha\beta+1}} \left(\frac{1}{e^{\beta_2 FP+\beta_3 FDI+\beta_4 TOP+\beta_5 Instit}}\right)^{\frac{\alpha}{\alpha\beta+1}} Y^{\frac{\alpha-(\alpha\beta+1)}{\alpha\beta+1}} \tag{10}$$

Finding the natural log of both sides of equation 10 yields;

$$\ln EI = \frac{\alpha\beta}{\alpha\beta+1} \ln\left(\frac{\alpha}{\beta}\right) - \frac{\alpha\beta}{\alpha\beta+1} \ln P_e - \frac{\alpha}{\alpha\beta+1} (\beta_2 FP + \beta_3 FDI + \beta_4 TOP + \beta_5 Instit) + \frac{\alpha-(\alpha\beta+1)}{\alpha\beta+1} \ln Y \tag{11}$$

For simplicity we can rewrite equation (11) as equation (11a), where γ_0 is the initial term on the right-hand side of equation (11) and γ_1, γ_2, γ_3 , γ_4 , γ_5 and γ_6 are the coefficients of crude oil price, financial performance indicator, FDI, trade openness, institutional quality and income respectively.

$$\ln EI = \gamma_0 - \gamma_1 \ln P_e - \gamma_2 FP - \gamma_3 FDI - \gamma_4 TOP - \gamma_5 Instit + \lambda_6 \ln Y \tag{E11a}$$

3.2 Empirical model and estimation technique

The use of energy intensity as a surrogate for energy efficiency has been criticized in the literature. This is because, energy intensity changes may mask other changes that do not really relate to energy efficiency improvements. For example, factors such as demography and production/economic structure can cause changes in energy intensity. To deal with this problem, we have controlled for a measure of economic structure/production. Further, we also control for urbanization as a measure of demography. We assume further that energy intensity exhibits persistence, as energy efficiency practices in previous periods are believed to be carried on to the current period. Thus, in the long-term, countries will conditionally converge to the same energy-use state. From equation (11), our empirical model can be expressed as;

$$\begin{aligned} \ln EI_{it} = \gamma_0 + \lambda \ln EI_{it-1} - \gamma_1 \ln P_{et} - \gamma_2 FP_{it} - \gamma_3 FDI_{it} - \gamma_4 TOP_{it} \\ -\gamma_5 Instit_{it} + \gamma_6 \ln Y_{it} + \boldsymbol{\gamma}\mathbf{X}_{it} + \eta_i + \nu_t + \varepsilon_{it} \end{aligned} \tag{12}$$

where $\gamma's$ takes on the initial definition and λ is the co-efficient of the lagged dependent variable. $\mathbf{X}$, is a vector of control variables such as urbanization and shift in economic structure. The time and country fixed effects are captured by ν_t and η_i respectively. The disturbance term is represented by ε_{it}. Return on asset, asset quality, bank capitalisation and managerial efficiency are used as indicators of bank performance whiles Z- score is used to measure the fragility of the financial system. We also formed a composite index of financial performance by applying principal component analysis (PCA) on the five indicators of financial performance. From Table A1 in the appendix, the eigenvalue shows that two of the components pass the criteria since the eigenvalue is greater than one. These components explain jointly about 55.3% of the variations in the financial performance indicators. We, however, made use of component 1 in our estimation since it explains a greater proportion of the variations in the financial performance indicators. Also, component 1 gives the expected sign of correlations with the financial performance indications as shown by the loadings in Table A2 (see appendix).

The sign of the parameter on economic structure depends on which measure one uses. Economic structure in this study is defined as a shift to the energy-intensive sector (i.e. industrialization). We use industry value added to indicate the level of industrialization/shift to the energy-intensive sector. In the case of FDI and trade openness, we used them as proxies for technological diffusion. Trade openness is measured as total trade as a percent of GDP, and FDI is measured as net inflow as a percent of GDP. An increase in the price of energy is expected to decrease energy intensity. We use world real crude oil price to measure the price of energy. The impact of income on energy intensity can be positive or negative.

Based on the estimates from equation (12), we further calculate the short- and long-run elasticities. For the independent variables which are natural log transformed, the coefficients are the short-run elasticities. However, for the independent variables which are not log transformed, the short-run elasticity is calculated by multiplying the estimated coefficient of each variable by the mean value[4] of the specific variable. The long-run elasticities for all the variables are obtained by dividing the short-run elasticity by one minus the estimated coefficient of the lagged independent variables (that is, energy intensity). [5]

As stated earlier in this paper, institutional quality can have both direct and indirect effects on energy intensity/energy efficiency. More directly, improved institutional quality will help strengthen the stringency of energy efficiency policies. Thus, directly, we expect improved institutional quality to promote energy efficiency. However, as argued above, where there exist pressure interest groups that oppose external financing, institutions (measure here as democracy) could lower financial intermediation in an economy and cause the energy efficiency-inducing effect of financial performance to be compromised. To test this indirect effect, we include an interactive term of institutional quality and financial performance in our model; this is shown in equation 13.

$$\begin{aligned}\ln EI_{it} = \gamma_0 + \lambda \ln EI_{it-1} - \gamma_1 \ln P_{et} - \gamma_2 FP_{it} - \gamma_3 FDI_{it} - \gamma_4 TOP_{it} \\ -\gamma_5 Instit_{it} + \gamma_6 \ln Y_{it} + \gamma_7 FP_{it} \times Instit_{it} + \boldsymbol{\gamma}\mathbf{X}_{it} + \eta_i + \nu_t + \varepsilon_{it}\end{aligned} \tag{13}$$

From equation 13, the marginal effect of banking performance on the natural log of energy intensity is derived as;

$$\frac{\partial \ln EI_{it}}{\partial FP_{it}} = -\gamma_2 + \gamma_7 Instit_{it} \tag{14}$$

From Equation 13, institutional quality reinforces the energy-saving impact of banking performance if$\gamma_7 < 0$. However, if$\gamma_7 > 0$, then institutional quality lessen the energy-saving role of banking performance. The total effect of financial performance on the natural log of energy intensity will be the coefficient of the banking performance indicator (when significant) if the interaction between banking performance proxy and institutional quality is not significant. However, in a case when both banking performance proxy and its interaction with institutional quality are significant, the total effect of banking performance on energy intensity would be equation 14 evaluated at the mean of institutional quality.

3.3 Econometric technique

We estimate Equations 12 and 13 using the two-stage system GMM. Due to the presence of the lag dependent variable which is a regressor in equations 12 and 13, the use of ordinary least squares may result in inconsistent estimates. Thus, the problems of autocorrelation and endogeneity may result when ordinary least squares technique is used to estimate equations 12 and 13. To address

[4] Mean value of variables can be seen in table 1

[5] $\eta_{LR} = \frac{\eta_{SR}}{1-\lambda}$ where η_{LR} and η_{SR} are the long- and short- run elasticities respectively.

these issues, Arellano and Bond (1991) proposed the one-step GMM difference method which introduces a set of internal instruments as the solution. However, Blundell and Bond (1998) noted that the one-step GMM difference approach suffers from bias, and the estimates are imprecise. This is because when the lag dependent variable and the set of explanatory variables exhibit inertia, the lag level variables become poor instruments.

The two-step system GMM rather solves this bias and imprecision by first assuming an independent and homoscedastic error terms and then uses the first-step residuals to construct consistent variance and covariance matrices in the second stage. But this approach also converges slowly to its asymptotic distribution which in finite sample cases make the standard errors downward bias (Amuakwa-Mensah and Adom, 2017). Windmeijer (2005) in this case suggest the use of multiple lags as instruments, but this could also create over-identification problem. In this study, we minimize the number of lags and then use the Sargan test to check for instrument validity. In order to test for serial correlation, we hypothesize serial correlation at first-order but no serial correlation at second-order.

3.4 Data sources and variable description

The study uses panel data covering 43 sub-Saharan Africa countries with data on key variables for the period 1998 to 2012. Whereas data on banking performance (return on asset), bank size (market capitalization), financial fragility (z-score), asset quality (non-performing loan) and managerial inefficiency (cost to revenue ratio) are sourced from the work of Andrianova et al. (2015), data on macroeconomic variables are from the World Bank's World Development Indicator (WDI). Energy intensity and crude oil price are from EIA and BP Statistical Review of World Energy (BPSRWE) respectively. Energy intensity is defined as the total primary energy consumption per Dollar of GDP (Btu per dollar of GDP[6]). For the institutional variable proxy (that is, polity 2), we sourced data from the Polity IV Project[7]. We define income as GDP per capita measured in constant US dollars.

Table 1 shows a definition of the variables used in the study with their respective descriptive statistics. The descriptive statistics show high variability in net FDI flows in Sub-Sahara Africa. On average, net FDI inflow is about 4.8% of GDP with a standard deviation of about 8.5%. Similarly, growth in industry value added is volatile with an average growth of about 4.6% and a standard deviation of 8.6%. The trade level in the region is moderately high with an average trade volume of about 74.5% of GDP and a standard deviation of 36%. In relation to the level of urbanization, an average of 35.8% of the total population lives in urban centres. In addition, the average real GDP capita in the sub-region is about 650[8] U.S dollars with a standard deviation of about 2.7 US dollars. The average quality of institution is a little above 0.5 which indicates

[6] Year 2011 U.S. Dollars (Purchasing Power Parities)
[7] http://www.systemicpeace.org/polity/polity4.htm
[8] Log transformation of the figure in table 1

moderate institutional improvement in the region. The energy intensity in the region has been high with an average of about 2090 btu per dollar of GDP, which indicates that countries in the region are energy inefficient.

For the bank level variables, there is high variability in return on asset among countries over the years with a mean value of about 2.3 and standard deviation of 2.4. The distribution of return on asset is positively skewed with more in tails than a normal distribution. The average market capitalization for banks in Sub-Sahara Africa is 11.5 with a standard deviation of 6.1. The distribution of market capitalization is positively skewed with more in tails than a normal distribution. The average asset quality is about 9.0, and the average managerial inefficiency is about 59.7.

The value of managerial inefficiency indicates that banks in Sub-Sahara Africa are relatively inefficient since their cost of operation to revenue ratio is about 59.7 on average. The standard deviation of managerial inefficiency is about 21.1. The average Z-score (a measure of financial fragility) is about 14 with a standard deviation of about 11.2. The smaller average Z-score indicates that banks in Sub-Sahara Africa are relatively less financially sound/stable. The distribution of financial fragility is positively skewed with more in tails than a normal distribution.

3.5 Unit root test and correlation matrix

Using panel Augmented dickey fuller (ADF) and Phillip-Perron (PP) tests; we performed a unit root test for the variables used in this study (see Table A3 in the appendix). These methods of unit root test are known to account for individual unit root process and as such deals with heterogeneity, making them more preferred over unit root tests that assume a common unit root process. The test shows that with the exception of GDP per capita, industry value added and crude oil prices, all the variables in this study are stationary in levels for both ADF and PP unit root test. The ADF and PP test for real GDP per capita, industry value added and crude oil price offer contradictory results. The ADF-based test concludes that variables are stationary in levels, but the PP-based test (which has more power than ADF-based test) concludes that these variables only become stationary after first difference. We found the first difference of the variables to make them stationary in both cases.

In the case of urbanization, the PP test confirms stationarity, but ADF test shows conflicting results. Whereas the inverse logit based test confirms non-stationarity of the series in levels, the Modified inverse chi-squared confirms stationarity of series in levels. We consider urbanization as stationary in this study since the modified inverse chi-squared tests confirm stationarity for the ADF and also both test under PP unit root are also stationary.

The correlation matrix for the variables used in the econometric estimations is shown in Table A4 in the appendix. We find no high correlation between the pair of variables in Table A4, indicating that the presence of multicollinearity in the econometric estimations is low. The correlation between per capita GDP growth and growth in industrial value added showed the highest correlation coefficient of about 0.46, followed by the correlation between return on asset and managerial inefficiency with a correlation coefficient of about -0.44, and the correlation between energy intensity and urbanization with a correlation coefficient of about 0.33. However, these figures are too low to be classified as perfect or near perfect correlation. Market capitalization and per capita GDP growth have the lowest correlation coefficient of about 0.002.

4 Results discussion

4.1 Unconditional impacts of banking performance

Table 2 shows the unconditional impact of banking performance on energy intensity. The columns in the table show a step-wise estimation where each indicator of banking performance is included separately from columns (2) to (6). In column 7, a composite financial performance index constructed from all the banking performance indicator is used. The Sargan and autocorrelation tests show all the models satisfy the over-identification and autocorrelation assumptions characterizing system GMM estimation technique. Thus, the Sargan test fails to reject the null hypothesis that over-identifying restrictions are valid. Also, whereas the 1^{st} order autocorrelation is significant in all the models, 2^{nd} order autocorrelation is not significant. Thus, our models meet the no autocorrelation assumption.

Based on the results in Table 2, short-run and long-run elasticity values are calculated in Table 3 using significant variables. For the explanatory variables with natural log transformations (that is, crude oil price, GDP per capita and industry value added), the coefficients in Table 2 are the short-run elasticities since the independent variable has been transformed into natural log. In the case of the other explanatory variables which are not transformed in Table 2, the short-run elasticity is calculated by multiplying the estimated coefficient of each variable by the mean value[9] of the specific variable. The long-run elasticities for all the variables are obtained by dividing the short-run elasticity by one minus the estimated coefficient of the lagged independent variables (that is, energy intensity) in Table 2.

From columns 2-6 of Table 2 different proxies for banking sector performance were introduced in a step-wise manner to examine the measured impact of these variables on energy intensity. From columns 2-6, it can be seen that whereas return on asset (ROA), market capitalization and financial soundness (stability) of the banking industry significantly improve energy efficiency (as shown by their negative effects on energy intensity), asset quality (that is, non-performing loans) significantly worsens energy efficiency (as shown by the positive effect on energy intensity). In the case of ROA, the short and long run elasticities are estimated as -0.009 and -0.07, respectively. For the banking industry as a whole, higher profitability is an indication of the sector's ability to invest in energy-efficient technologies to improve the operational efficiencies. For the business

[9] Mean value of variables can be seen in table 1

of lending, higher profitability signifies the potential growth in banks' credit business. Thus, investment in more energy-saving technologies are likely to be enhanced, all other things being equal. From column 3 of Table 3, the short- and long-run elasticities associated with market capitalization are estimated as -0.03 and -0.244, respectively. Large banks can enjoy both economies of scale and scope and as such can invest in energy saving gadgets. In addition, with the increase in bank size, they are able to provide guarantee or leverage for the state when the state is acquiring energy efficient technologies which are most capital intensive.

The short- and long-run elasticities for financial stability are estimated as -0.084 and -0.661 (see column 6 in Table 3) respectively. Financial stability contributes to investment in research and advanced technologies thereby increasing competition in the market, which in effect help improve the efficient use of energy (Islam et al., 2013; Kakar, 2016). Finally, the short- and long-run elasticities for asset quality/non-performing loan are estimated in column 4 of Table 3 as 0.013 and 0.183, respectively. The positive elasticity is an indication that poor asset quality compromises energy efficiency improvements. As more loans turn bad, it shrinks the growth of the bank, and this constrains the banks from lending out funds to investors thereby affecting investment in energy-saving technologies. In situations where banks are even able to lend funds to investors, they do so at a higher cost (that is, high-interest rate) which makes investment not worthwhile. Furthermore, an increase in non-performing loans can also affect the operations of the banks in such a way that they may be using crude technologies which are not energy efficient. Although managerial inefficiency positively affects energy intensity, it is not significant.

Altogether, the results support the claim that improvements in various aspects of the banks' balance sheet can foster energy efficiency improvements in sub-Saharan Africa. As a further check on this result, we constructed a composite bank performance index using the PCA. The result is as shown in column 7 of Table 2. We find that the composite bank performance index has a significant negative effect on energy intensity, supporting the claim that general improvement in bank performance will foster energy efficiency improvements. The last column of Table 3 shows the estimated short- and long-run elasticities for the composite bank performance index as -0.001 and -0.01 respectively.

Further results in Table 2 show that, energy intensity exhibits persistence as previous level of energy intensity significantly affects current level of energy intensity. This effect is positive, indicating that if an economy is energy efficient in previous period then it will also be energy efficient in current period since the knowledge used in achieving efficiency can be passed on to the next periods. In other words, in the long-term, there will be conditional convergence of countries to the same energy-use state. The responsiveness of current energy intensity to previous year's energy intensity ranges from 0.87 to 0.93 based on Table 2, which is very high. Ramos-Real et al. (2015), using a panel data of 123 countries, finds similarly high persistent effect of energy intensity. Also in Table 2, we observe a positive effect of crude oil price, FDI and industry value added on energy intensity.

The positive effect of crude oil price on energy intensity means that an increase in crude oil price leads to an increase energy inefficiency. While this from the theoretical point of view seems contradictory, it affirms the story in sub-Saharan Africa. Governments in these regions normally engage in different pricing tools just to protect the poor from the high cost of fuels. They include price controls and reduction in consumption fuel taxes. In 2011, for example, almost more than half of countries in Africa had some form of subsidy in place to guard the poor against high fuel cost. Total expenditure on fuel subsidy in that year accounted for 1.5% of GDP. While this expenditure relieves program by the government may be good from a welfare perspective, it has the negative effect of not stimulating energy efficient investment and energy conservation practices. Thus, in the end, the subsidized energy price may compromise energy efficiency in the sub-region. Adom and Amuakwa-Mensah (2016) find a similar result for the middle-income countries group in Eastern Africa. From Table 3, both the short- and long-run price elasticities are very low, which somewhat relatively underplays the importance of price as an energy-saving tool in the region.

In the same vein, the positive effect of FDI means that FDIs do not improve energy efficiency in sub-Saharan Africa. From Table 3, the short-run elasticity ranges from 0.004 to 0.016, while the long-run elasticity ranges from 0.031 to 0.225. This result could be explained as an evidence of the existence of the pollution-haven hypothesis in sub-Saharan Africa, which states that countries with lax environmental policies experience the inflow of energy inefficient technologies. The sub-region as know does not have very strict environmental policies. Therefore, it is seen as the home for most energy inefficient firms who cannot operate in their current location due to the stringent environmental policies there. Consequently, energy efficiency becomes compromised in the sub-region. As revealed by Adom and Amuakwa-Mensah (2016), the kind of FDI a country receives is driven by the political environment. Our result is in contrast to that of Adom (2015a, 2015b), Elliott et al. (2013), Eskeland and Harrison (2003), Herrerias et al. (2013), Hübler (2011) and Zheng et al. (2011), but confirms the findings of Adom and Amuakwa-Mensah (2016), Adom and Kwakwa (2014) and Hübler and Keller (2010).

In addition, growth in industry value added positively affects energy intensity as expected (see Table 2). The short-run elasticity ranges from 0.12 to 0.22, while the long-run elasticity ranges from 0.93 to 3.04. These findings corroborate that of Adom and Amuakwa-Mensah (2016), Adom and Kwakwa (2014), Herrerias et al. (2013) and Li and Lin (2014). The positive elasticity indicates that growth in the energy-intensive sectors will compromise energy productivity or energy efficiency. This sounds tricky for a sub-region that is less industrialized and seeks to be industrialized in the future. In the short-run, we can contain this trade-off associated with industrialization drive. However, in the long-term, massive commitment must be made in investing in cleaner energy forms and efficient technologies.

Finally, Table 2 shows evidence of the energy-saving role of income, institutional quality, trade and urbanization. Our estimations show that growth in income per capita by one percent significantly reduces energy intensity by 0.57-

1.07%, in the short-run. However, the long-run elasticity calculations show that energy intensity reduces by 7.5 – 13.6% if income per capita increases by 1% (see table 3). This negative effect may either be the result of investment in energy-efficient technologies or a change in the structure of demand away from energy-intensive products to less energy-intensive products, as income increases. Our findings are in line with that of Adewuyi and Adeniyi (2015), Adom (2016), Adom and Amuakwa-Mensah (2016), Azam et al. (2015), Kyophilavong et al. (2015), Rafindadi and Ozturk (2016) and Shahbaz et al. (2013).

The short- and long-run elasticities of trade range from -0.022 to -0.15 and -0.17 to -2.1 respectively. Trade openness tends to make countries to trade in technology, and this increases the rate of technological diffusion which affects energy productivity positively in an economy. Thus, trade openness becomes a more effective mechanism for technological transfer which helps reduce energy intensity. Also, trade openness exposes domestic firms to international competition, which compels them to invest in energy-efficient technologies in order to remain competitive. The negative impact of trade openness on energy intensity may be an indication that, in sub-Saharan Africa where there is high import dependence, the technical and composition effects of trade dominate. The energy efficiency-inducing effects of trade confirm the findings of Adom (2015a, 2015b) and Adom and Amuakwa-Mensah (2016).

Institutional quality is observed to improve energy efficiency (see columns 4 and 7 of Table 2). The short-run elasticity is -0.056, while the long-run elasticity ranges from -0.571 to -0.775. The result supports the claim that good institution strengthens (or do not compromise) energy efficiency policies and this help promote energy efficiency. Similarly, Ramos-Real et al. (2015) find that good institution reduces energy intensity for 123 countries. Lastly, we observe a negative relationship between urbanization and energy intensity. Whereas the short-run elasticity of energy intensity to urbanization is about -0.22, that of the long-run ranges from -1.68 to -2.95. This suggests that the responsiveness of energy intensity to urbanization in the long-run is elastic. The adverse effects of urbanization suggest possible economies of scale associated with urbanization in sub-Saharan Africa. The negative effect observed in our study is consistent with that of Poumanyvong and Kaneko (2010) who found that urbanization significantly reduces energy intensity in low-income countries and also the results of Liddle (2004).

4.2 The indirect effect of institutional quality on energy intensity

Table 4 shows the estimation of equation 13, where we examine the indirect effect of institutional quality. As argued above, through an indirect means, institutional quality (measured here as democracy) can moderate the energy-saving effects of performance indicators, where there are pressure interest groups in the economy that oppose external financing. Table 4 shows that, directly, good institution foster energy efficiency. However, indirectly, institutional quality moderates the energy-saving role of performance indicators. For ROA, market capitalization, and financial soundness, democracy indirectly reduces the energy-saving effect role of these variables. Profitability, market size and financial stability are impacted by the degree of external financing. Therefore, in a democratic environment where there exist pressure interest groups that oppose external financing, the financial sector is likely to face repression, which in turn will reduce the energy-saving potential of performance indicators. The total effects of ROA, market capitalization and financial stability on energy intensity are negative. Thus, although democracy seems to moderate down the energy-saving effects of these performance indicators, on the whole, increasing profitability, market capitalization and financial soundness generally foster energy efficiency improvements.

For asset quality and managerial inefficiency, there seems to be the evidence that direct effects are negative, which implies non-performing loans and higher managerial inefficiency leads to energy intensity reduction. While this seems to contradict our earlier result, it does not look very surprising since both asset quality and managerial inefficiency relates to some investment of some form. Assuming that, the high managerial inefficiency resulted due to investment made in energy efficient appliances, it is possible to see a reduction in energy intensity. Similarly, if loans acquired were invested in energy efficient technologies, then energy intensity may decrease even if we experience non-performing loans. Indirectly, however, democracy seems to create the energy dissaving effects of these performance indicators causing their total effects to be positive.

The existence of pressure interest groups in a democratic system can create a 'grandfathering' system, which makes it very difficult for banks sometimes to recoup their debts. Particularly, in sub-Saharan Africa, the phenomenon of "foot soldiers"- that is party faithful who supported the ruling government when they were in opposition – put pressure on the ruling government to provide protection for them sometimes as a guarantee or rescuer. Using the composite bank performance index, the results show that institutional quality directly promotes energy efficiency but indirectly reduces the energy-saving potential of bank performance. Nonetheless, the total effect of bank performance on energy intensity is negative. Thus, in general, improved bank performance will foster energy efficiency improvements in sub-Saharan Africa.

Further, the other results are consistent. Income, trade openness and urbanization foster energy efficiency improvements but FDI, industry value added and oil price compromise energy efficiency improvements. Diagnostics for the GMM estimation shows that, the instruments are valid and there is no serial correlation problem.

5 Concluding remarks

This study examined the drivers of energy intensity in 43 sub-Saharan African countries. The article test two important hypotheses: (1) improved banking performance does not foster energy efficiency improvements and (2) institutional quality (democracy) does not compromise the energy-saving role of improved banking performance. To achieve the above goal, the article uses a unique banking data by Andrianova et al. (2015) and employs the two-step system generalized method of moment (GMM) technique as the estimation technique. The data period covers 1998 to 2012. The following results emerged from the study.

First, improved banking performance, as measured by various indicators, foster energy efficiency improvements in sub-Saharan Africa. Thus, from energy security perspective, creating the enabling environment and removing market barriers for banking operation to thrive should be given attention. For example, programs such as tax rebates and energy subsidy for the sector could be a step in the right direction. More ambitiously, creating a regional green bank in the sub-region may stimulate energy efficiency investments and hence promote energy efficiency in the sub-region. Banks in sub-Saharan African countries are underdeveloped, and countries either do not have functioning credit reference bureau system or for those who have, it is not fully utilized. Creating a national/regional credit reference bureau system would enable banks to assess the creditworthiness of clients before issuing a loan; this will help reduce the possibility of bad debts. From the results, the close connection between banking operation and the energy sector suggests that, government policies should be integrated in nature.

While all the above may be necessary to ensure energy efficiency improvements in the sub-region, the political environment also matters. As indicated in this article, a democratic environment characterized by the existence of pressure interest groups can compromise the energy-saving role of improved banking performance. Thus, for the general good, democratic governance in the sub-region should find ways to wean themselves of things that affect the progress of the real sector.

The task of promoting energy efficiency, however, is multifaceted in nature. As revealed in this paper, openness policy and economic growth are necessary, as well as the conscientious attempt to strengthen environmental policies to prevent the pollution-haven hypothesis and remove fuel subsidies for the non-banking sector. Given the high poverty incidence in the sub-region, the removal of subsidies may compromise welfare in the short-run. However, in the long-run, this will be reversed since the growth benefits associated with energy efficiency improvements can be redistributed back to the poor in the form of improved social intervention programs in education, housing, and health.

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Table 1: Description of variables and statistics

VARIABLES	Definition	(1) N	(2) Mean	(3) Sd	(4) min	(5) Max	(6) skewness	(7) Kurtosis
FDI	Foreign direct investment, net inflows (% of GDP)	609	4.847	8.467	-5.980	91.01	5.147	40.30
Trade	Trade volume (% of GDP)	599	74.48	35.79	20.96	209.9	1.168	4.242
Urbanization	Urban population (% of total)	614	35.80	15.51	7.830	86.37	0.611	3.452
Market Capit.	Market Capitalization (Equity/Total assets)	577	11.49	6.11	-11.74	69.28	3.266	24.75
Asset quality	Asset quality (Impaired Loan/Gross Loan)	421	8.998	8.092	0.0300	55.47	1.999	8.257
Manag Ineffi	Ratio of cost to revenue (Cost / Revenue)	564	59.68	21.05	3.810	230.6	1.568	13.23
ROA	Return on asset (Net Income / Total Assets)	574	2.315	2.406	-10.57	21.79	1.391	18.19
Financial Sound	Financial fragility, $Z_{it} = \frac{ROA_{it} + equity_{it} / assets_{it}}{\sigma ROA_i}$	574	13.96	11.17	-7.881	73.89	2.109	9.418
Institution	Proxied by polity2. The polity score is computed by subtracting the p_autocracy score from the p_democracy score	614	0.581	0.264	0	1	-0.125	1.758
Lnei	Natural log of Energy intensity (ratio of energy consumption to GDP)	612	7.645	0.675	5.078	9.346	-0.460	5.180
lnGDPPC	Natural log of real GDP per capita	614	6.477	1.008	4.804	8.940	0.881	2.903
lnCOP	Crude oil price	629	3.810	0.667	2.543	4.716	-0.260	1.867
dlnIVA	Growth in Industry, value added	501	0.0457	0.0858	-0.338	0.594	1.231	12.39

NB: σROA_i is a country-specific standard deviation of the national average value of ROA (ROA_{jt}) over time

Table 2: Unconditional impacts of banking performance on Energy Intensity

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
L.lnei	0.927***	0.872***	0.877***	0.929***	0.897***	0.873***	0.902***
	(0.0335)	(0.0409)	(0.0431)	(0.0134)	(0.0392)	(0.0463)	(0.0112)
dlnCOP	0.0413***	0.0566***	0.0549***	0.0664***	0.0523***	0.0512***	0.0697***
	(0.00575)	(0.00676)	(0.00870)	(0.00545)	(0.00682)	(0.0110)	(0.00885)
dlnGDPPC	-0.567***	-0.930***	-0.925***	-0.963***	-0.856***	-0.947***	-1.068***
	(0.0677)	(0.0910)	(0.0919)	(0.0411)	(0.0753)	(0.101)	(0.0566)
FDI	0.0013***	0.0009***	0.000776***	0.0032***	0.001***	0.000598	0.00290***
	(0.00037)	(0.0002)	(0.000246)	(0.00029)	(0.000187)	(0.00037)	(0.000376)
Trade	-0.001***	-0.0003**	-0.000215	-0.002***	-0.0004**	-0.000278	-0.0014***
	(0.00031)	(0.000139)	(0.000148)	(0.000179)	(0.000181)	(0.000205)	(0.000193)
dlnIVA	0.0314	0.119***	0.117***	0.216***	0.0993**	0.121***	0.172***
	(0.0335)	(0.0410)	(0.0393)	(0.0242)	(0.0420)	(0.0365)	(0.0238)
Institution	0.00894	0.0172	0.0139	-0.094***	0.0262	0.0396	-0.0970***
	(0.0300)	(0.0311)	(0.0230)	(0.0224)	(0.0274)	(0.0353)	(0.0260)
Urbanization	-0.006***	-0.006***	-0.0063***	0.000589	-0.006***	-0.006***	0.00073
	(0.00125)	(0.001)	(0.00110)	(0.00101)	(0.00106)	(0.000926)	(0.00104)
ROA		-0.004***					
		(0.00144)					
Market Cap.			-0.00259***				
			(0.000805)				
Asset quality				0.0014***			
				(0.00032)			
Manag. Ineff.					1.21e-05		
					(0.000140)		
Fina. Sound.						-0.006***	
						(0.000944)	
Fina. Index							-0.0108***
							(0.002)
Constant	0.817***	1.209***	1.203***	0.679***	1.015***	1.269***	0.888***
	(0.286)	(0.330)	(0.346)	(0.0834)	(0.326)	(0.352)	(0.0616)
Observations	468	437	440	320	430	437	320

No. countr.	36	35	35	34	35	35	34
Wald test	9241.0***	6166.5***	13404.4***	56949***	8503.2***	140839***	1412255***
Sargen's test	25.8(0.42)	22.9(0.59)	24.1(0.52)	26.1(0.40)	24.4(0.50)	26.4(0.38)	24.4(0.49)
1st order auto	-3.16***	-2.62***	-2.68***	-2.87***	-2.68***	-2.68***	-2.86***
2nd order aut.	1.02	0.77	0.59	-0.06	0.64	0.38	0.10

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. For the Sargan's test, we presented the chi-square values and the associated p-values are in parentheses. We presented the z-values for the autocorrelation test.

Table 3: Short-run and long-run Energy Intensity elasticities calculation based on Table 2

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Short-Run Elasticity							
Crude oil pr.	0.0413	0.0566	0.0549	0.0664	0.0523	0.0512	0.0697
GDP perCap	-0.567	-0.930	-0.925	-0.963	-0.856	-0.947	-1.068
FDI	0.006	0.004	0.004	0.016	0.005	---	0.0141
Trade	-0.074	-0.022	---	-0.149	-0.03	---	-0.104
IVA	---	0.119	0.117	0.216	0.0993	0.121	0.172
Institution	---	---	---	-0.055	---	---	-0.056
Urbanization	-0.215	-0.215	-0.226	---	-0.215	-0.215	---
ROA		-0.009					
Market Cap.			-0.03				
Asset quality				0.013			
Manag. Ineff.					---		
Fina. Sound.						-0.084	
Finan. Index							-0.001
Long-Run Elasticity							
Crude oil pr.	0.566	0.442	0.446	0.935	0.508	0.403	0.711
GDP perCap	-7.787	-7.266	-7.52	-13.56	-8.311	-7.457	-10.898
FDI	0.082	0.031	0.033	0.225	0.049	---	0.144
Trade	-1.014	-0.172	---	-2.099	-0.291	---	-1.061
IVA	---	0.93	0.951	3.042	0.964	0.953	1.755
Institution	---	---	---	-0.775	---	---	-0.571
Urbanization	-2.945	-1.68	-1.837	---	-2.087	-1.693	---
ROA		-0.070					
Market Cap.			-0.244				
Asset quality				0.183			
Manag. Ineff.					---		
Fina. Sound.						-0.661	
Finan. Index							-0.010

Table 4: Conditional impacts of banking performance on energy intensity

Variables	(1)	(2)	(3)	(4)	(5)	(6)
L.lnei	0.868***	0.914***	0.911***	0.915***	0.859***	0.918***
	(0.0385)	(0.0427)	(0.0157)	(0.0412)	(0.0515)	(0.011)
dlnCOP	0.0597***	0.0513***	0.0692***	0.0460***	0.0517***	0.0764***
	(0.00729)	(0.00991)	(0.00493)	(0.00621)	(0.0121)	(0.011)
dlnGDPPC	-0.992***	-0.870***	-0.970***	-0.795***	-0.909***	-0.976***
	(0.0912)	(0.0895)	(0.0534)	(0.0780)	(0.107)	(0.050)
FDI	0.000862***	0.00108***	0.00268***	0.000759**	0.000876**	0.0025***
	(0.000208)	(0.000295)	(0.000425)	(0.000323)	(0.000398)	(0.00046)
Trade	-0.000302	-0.000309	-0.0012***	-0.000383*	-0.000492*	-0.0013***
	(0.000194)	(0.000196)	(0.000196)	(0.000214)	(0.000269)	(0.0005)
dlnIVA	0.126***	0.0975**	0.206***	0.0850**	0.119***	0.174***
	(0.0386)	(0.0388)	(0.0271)	(0.0425)	(0.0349)	(0.0223)
Institution	-0.0253	-0.131***	-0.252***	-0.154**	-0.0708	-0.136***
	(0.0338)	(0.0291)	(0.0492)	(0.0696)	(0.0446)	(0.0481)
Urbanization	-0.00649***	-0.00571***	0.000945	-0.00708***	-0.0064***	0.0006
	(0.00124)	(0.000941)	(0.00123)	(0.00104)	(0.000831)	(0.0009)
ROA	-0.0135***					
	(0.00194)					
Institu*ROA	0.0195***					
	(0.00541)					
Market Cap.		-0.0112***				
		(0.000733)				
Insti*MarkCap		0.0136***				
		(0.00120)				
Asset quality			-0.00423**			
			(0.00181)			
Insti*asset qua			0.0108***			
			(0.00307)			
Manag. Ineff.				-0.00104**		
				(0.000494)		
Insti*Manag.Ine				0.00272***		
				(0.000892)		
Finan. Soundne					-0.0106***	
					(0.00147)	
Insti*Fina Soun					0.00755***	
					(0.00206)	
Fina. Index						-0.0403***
						(0.0067)
Insti*Fina.Index						0.0438***
						(0.0108)
Constant	1.282***	0.982***	0.869***	0.988***	1.464***	0.779***
	(0.328)	(0.347)	(0.0921)	(0.321)	(0.395)	(0.0803)
Total Effect	-0.0021	-0.003***	0.002***	0.0005**	-0.0062***	-0.015***
	(0.0017)	(0.0004)	(0.0004)	(0.0002)	(0.00075)	(0.0017)
Observations	437	440	320	430	437	320

No. countries	35	35	34	35	35	34
Wald test	9499.3***	19128.5***	98598***	10657.6***	9334.8***	130748***
Sargan's test	21.4(0.67)	22.4(0.61)	25.8(0.42)	27.6(0.33)	24.6(0.49)	26.43(0.38)
1st order auto	-2.73***	-2.72***	-2.84***	-2.74***	-2.60***	-2.85***
2nd order aut.	0.82	0.38	-0.06	0.66	0.51	0.01

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. For the Sargan's test, we presented the chi-square

Appendix

Table A1: Eigen values from Principal Component Analysis

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	1.679	0.595	0.336	0.336
Comp2	1.085	0.125	0.217	0.553
Comp3	0.960	0.197	0.192	0.745
Comp4	0.762	0.248	0.152	0.897
Comp5	0.514	.	0.103	1.000
Kaiser-Meyer-Olkin				0.517

Table A2: Principal component loadings

Variable	Comp1	Comp2	Unexplained
ROAA	0.487	-0.562	0.259
Equity	0.382	0.253	0.686
Imps	-0.431	-0.362	0.546
Costs	-0.512	0.413	0.375
Z	0.412	0.564	0.370

Table A3: Unit root test

	ADF		Phillips-Perron	
	Inverse logit	Modified inv. chi-squared	Inverse logit	Modified inv. chi-squared
ROA	-13.20***	17.78***	-5.93***	6.87***
Asset quality	-8.96***	11.35***	-1.81**	2.26**
Market capilization	-11.75***	15.83***	-6.67***	10.66***
Managerial inefficiency	-12.46***	16.72***	-5.13***	6.64***
Financial soundness	-12.29***	16.64***	-7.72***	12.29***
Lnei	-11.70***	15.62***	-5.47***	9.00***
FDI	-14.95***	21.64***	-9.58***	14.96***
Urbanization	19.19	15.87***	-25.02***	25.34***
lnGDPPC	-4.59***	6.52***	4.18	-0.67
ΔlnGDPPC	-20.32***	30.46***	-17.79***	26.55***
lnIVA	-3.98***	5.60***	4.17	-2.00
ΔlnIVA	-17.86***	26.46***	-14.23***	20.96***
Institution	-9.98***	13.11***	-3.95***	3.19***
lnCOP	-8.35***	9.23***	0.94	-2.79
ΔlnCOP	-24.38***	37.65***	-23.17***	35.46***

*** p<0.01, ** p<0.05, * p<0.1

Table A4: Correlation Coefficient

	Lnei	dlnCOP	dlnGDPPC	FDI	Trade	dlnIVA	Institution	Urbanization	ROA	Market Capitali.	Asset quality	Manag. Ineffi	Financial Soundness
Lnei	1.000												
dlnCOP	0.015	1.000											
dlnGDPPC	-0.070	0.033	1.000										
FDI	0.038	0.019	-0.037	1.000									
Trade	0.138***	0.020	0.028	0.311***	1.000								
dlnIVA	-0.009	0.061	0.458***	0.161***	0.011	1.000							
Institution	0.213***	-0.017	0.149***	-0.022	0.046	0.045	1.000						
Urbanization	0.334***	-0.023	-0.018	0.137***	0.262***	-0.098**	0.120***	1.000					
ROA	0.041	0.073*	-0.062	-0.106**	-0.001	-0.068	-0.049	-0.088**	1.000				
Market Capit	0.125***	0.014	0.002	-0.035	0.131***	-0.044	0.043	0.042	0.103**	1.000			
Asset quality	-0.117**	0.007	-0.078	-0.003	-0.17***	-0.020	-0.032	-0.089*	-0.100**	-0.13***	1.000		
Manag. Ineff	0.095**	-0.073*	0.046	0.111***	-0.043	0.160***	0.050	0.058	-0.44***	-0.041	0.191***	1.000	
Fina. Sound	0.064	0.007	-0.074*	-0.086**	0.081*	-0.108**	0.277***	0.135***	0.032	0.265***	-0.24***	-0.19***	1.000

***** p<0.01, ** p<0.05,*p<0**