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Political Economy of Reform and Regulation in the Electricity Sector of Sub-Saharan Africa

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Keywords Iindependent regulation; electricity sector reform; government ideology; dynamic GMM; Sub-Saharan Africa.

JEL Classification D73, Q48, L51, L94, O55, P16

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Abstract

As part of their electricity sector reforms, Sub-Saharan African countries have established independent regulatory agencies to signal legal and political commitment to end self-regulation and provision of service by the state. The reforms aimed to encourage private investments, improve efficiency, and extend the service to the millions who lacked access to it. However, after nearly two and half decades of reforms, these expectations have not been met and the electricity sectors of these countries remain undeveloped. There are anecdotes that these outcomes are due to poor design, non-credible, unpredictable regulations, and political interference. This paper investigates the performance of the reforms in the context of government political ideology. We use a dynamic panel estimator and data from 45 countries from 2000 to 2015 to analyse the role of ideological differences in the effect of independent sector regulation on access to electricity and installed capacity. We find negative impact from independent regulatory agencies on installed capacity in countries with left-wing governments, while in countries with right-wing governments we find positive effects on capacity. Also, we find negative impact on access in countries with left-wing governments, while we find no significant impact for countries with right-wing governments. The results have interesting policy implications for private sector participation, increased generation capacity and access rates especially in countries with left-wing governments.

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1. Introduction

Over the past three decades, Sub-Saharan African (SSA) countries have aimed to reduce public ownership of electricity utilities through sectoral reforms. The reforms were partly due to critical budgetary conditions and part of macroeconomic stabilisation programs. Although no country in the region have implemented all steps of comprehensive reforms,[1] the reforms have largely ended the era of self-regulation of the sector by the state. In its place, Independent Regulatory Agencies (IRAs) were created to regulate; set standards; define terms of interconnection among networks; issue, enforce or alter licences; and prevent abuse of dominant market position.[2]

These objectives suggest IRAs were primarily established to promote economic regulation. However, as Thatcher (2002) noted, independent regulators (as in other sectors) were also delegated powers over 'social' matters such as the promotion of universal access to services and protection of consumers from exploitations. In order to fulfil these mandates, IRAs were expected to reduce the risk to the private sector to increase generation capacity and extend the reach of electricity services (Jamasb et al., 2015) to the millions without access in the region (IEA, 2014). Despite the expected performance improvements from regulatory changes, SSA countries have struggled to provide efficient and affordable electricity services to businesses and households (Eberhard et al., 2011) due to low generation capacity and underdeveloped distribution and transmission networks (World Bank, 2017; Ahlborg et al., 2015).

Some studies have linked the poor reform outcomes in developing countries to historical, financial, social, technical, political as well as economic factors (e.g., Dorman, 2014; Eberhard et al., 2011). Some researchers have shifted their attention to the institutional and political context within which IRAs are embedded and perform their regulatory functions (e.g., Imam et al., 2019; Pearce, 2006; Nepal and Jamasb, 2012a; Chang and Berdiev, 2011; Eberhard, 2007). These studies suggest that IRAs are susceptible to interferences particularly in countries with long history of weak institutions and unpredictable political intervention. For example, in countries with weak institutions, governments may intervene in the functions of IRAs to favour state utilities at the expense of private utilities or require the IRAs to set artificially low tariffs which would erode the investments by private utilities (World Bank, 1993).

As the reforms in the region have not led to full withdrawal of the state from the sector but rather to the emergence of hybrid electricity sectors with dominant state-owned utilities (Eberhard et al., 2016), there has been a lack of compatibility in these sectors between the governments political ideologies and the reforms which were often viewed as a neoliberal agenda (Gore et al., 2018). Therefore, in some SSA countries regulators have struggled to

[1] With the exception of Nigeria, which have implemented all features of the reform model.
[2] These agencies were created as part of electricity sector reforms which were heavily advocated to developing countries by the International Monetary Fund (IMF) and the World Bank.

cater for the economic incentives of private utilities and social objectives of governments such as increasing access to affordable electricity services.

Despite the anecdotes that relate government ideology to regulatory outcomes in the region, there is a lack of empirical evidence that links political interference in the IRAs functions to electricity sector performance. Some studies have shown how energy regulators function under different institutional settings such as different government ideologies (e.g., Pitlik, 2007; Potrafke, 2010; Hibbs, 1977; Alesina, 1987). These studies suggest that right-wing governments tend to favour deregulation and privatisation, while left-wing governments favour interference in regulatory functions to advance their social objectives. Some studies have focused on the effect of government ideology on regulatory output (e.g., Fudge et al., 2008; Conway and Nicoletti, 2006; Serralles, 2002; Damsgaard, 2003). However, most of these studies are either theoretical or on the experiences of developed countries where data are readily available.

To our knowledge, the present paper is among the few studies to empirically assess the impacts of electricity sector reforms in SSA countries (e.g., Imam et al., 2019) and is the first to empirically examine the effects of interactions between government ideologies of SSA countries and independent electricity sector regulators. Most studies of this strand of literature on developing countries tend to focus on specific aspects of institutional quality such as corruption (e.g., Imam et al., 2019; Estache et al., 2009; Wren-Lewis, 2015) or on specific countries without explicitly accounting for the role of political ideology apart from those earlier mentioned.

We use a dataset on government ideology first compiled by Beck et al. (2001) and later updated by Cruz et al. (2018) to investigate whether there are ideological differences in the effects of IRAs on electricity sector performance among SSA countries. Following Potrafke (2010), we divide our sample into three different government ideologies – left-wing, right-wing, and centrist – in order to reflect the ideological orientation and different economic and social objectives of SSA countries. Whether a government transfers functions such as provision of electricity service to the private sector and make non-interference commitments depends not only on the degree of independence of the regulator, but also on the prevailing ideological orientation of the governments.

This paper makes two contributions to the literature. First, we contribute to the analysis of the institutional aspect of the reforms (e.g., Imam et al., 2019; Nepal and Jamasb, 2012a, 2012b; Dorman, 2014; Erdogdu, 2013) and the political economy literature on regulatory agencies (e.g., Kapiki and Eberhard, 2013; Pitlik, 2007; Potrafke, 2010; Scott and Seth, 2013). Second, our analysis of political ideology and electricity reforms provide insights into why some SSA countries choose to reform while others do not. Why is it difficult to implement the Chilean and the United Kingdom examples of rapid and full implementation of the textbook reform model? Why start reforms with the generation rather than the distribution segment? And, whether there are differences among reforming countries in terms of political commitments to allow regulatory agencies to function unhindered.

The remainder of this paper is organised as follows. We review the literature on energy reforms and ideology in Section 2. Section 3 presents our model, which tries to capture how government ideologies and independent regulators influence SSA countries' electricity sector performance. The section further presents our estimation strategy and the data used. Section 4 discusses the obtained results. Section 5 concludes the paper.

2. Literature review

The role of energy in economic development has been well established in the literature even though there is no clear consensus on the direction of causality between them (Masih and Masih, 1997; Lorde et al., 2010; Burk et al., 2018).[3] Notwithstanding, electricity is essential for the smooth operation of modern communications, industrial development, and enhancement of social amenities such as healthcare and education (e.g., Ahlborg et al., 2015). Due to its welfare enhancing effects electricity generation, transmission, distribution, and retailing have historically been the prerogative of the state and public sector and therefore closed to private investment (Conway and Nicoletti, 2006).

The historical dominance of the state was mainly due to the view that provision of electricity is among the central functions of governments especially in countries where the state occupies a large space in the economy (Victor and Heller, 2011). As a result, the electricity sector in most countries was dominated by vertically integrated state-owned utilities (Eberhard et al., 2005). Even in countries with significant number of private utilities such as the United States (Min, 2008), the government funded the development and construction of national electricity infrastructure such as the Tennessee Valley Authority and the Hoover Dam in 1920s and 1930s (Garwood and Tuthill, 1963; Hirsch, 1999). The Soviet Union at its founding in 1920s, created the State Commission for Electrification of Russia (GOELRO) to extend electricity services to the entire country (Min, 2008). Similarly, the governments of Germany, Netherlands, and Scandinavia made political commitments to connect 90% of households by 1930 (Nye, 1992). In effect no country successfully extended electricity to all its parts without the support of the state (Barnes and Floor, 1996).

However, beginning in the 1980s and in response to a combination of political, ideological, economic and technological factors the sector has undergone extensive restructurings to facilitate market solutions and private sector investments and participation (Jamasb et al., 2015). These restructurings, which were also referred to as the "Standard Textbook Reform Model", were part of a broader set of economic policy objectives that formed part of the 'Washington Consensus'. The reform model which were first implemented in Chile and the United Kingdom, showed that effective implementation would enhance technical efficiency by reducing generation costs and price-cost gaps, and increase investment (Jamasb et al.,

[3] A literature review by Narayan and Prasad (2008) showed that two-thirds of the studies published in the journals *Energy Policy* and *Energy Economics* find that energy production and consumption lead to economic growth in developed and developing countries.

2015). Moreover, the efficiency gains were expected to be translated into affordable access to improved services.

The electricity reforms aim to reduce the dominance of state-owned utilities in the sector (Dornan, 2014). Following the experiences of the pioneers and other OECD countries, developing countries were encouraged by the IMF and the World Bank to unbundle the key functions of the electricity sector. These countries would then privatise the unbundled parts amenable to competition or regulation to the private sector and create independent regulatory agencies to supervise and regulate the monopoly-prone parts of the sector (Victor and Heller, 2007). Therefore, the main features of the Electricity Sector Reform (ESR) in developing countries were the introduction of market competition and private sector participation into the electricity markets.

In the 1990s, SSA countries began to implement ESR, even though no country in the region succeeded in implementing the entire suite of the reform model with the exception of Nigeria. This is because some aspects of the ESR model were viewed by politicians to pose differential risks; thus the reform parts considered as low-threats (e.g., entry of Independent Power Producers, IPPs) were mostly encouraged (Karekezi et al., 2004). Also, resistance to tariff increases by citizens who associate the reforms with neoliberal agenda, labour unions with socialist traditions, and Africans educated with Afro-socialist leaning views, galvanise to pressurise politicians to resist reforms even if the governments' view on ESR were positive (Batley, 2004; van de Walle, 1989; Gore et al., 2018).

Notwithstanding the politics surrounding the implementation of reforms in the region, as of 2014, 24 countries had enacted ESR laws, three-quarters had attracted private sector participation, two-thirds had corporatised their electricity utilities, a similar number had set-up regulatory bodies, and more than a third had IPPs in place (Eberhard et al., 2008). As a result, the dominance of governments in the sector has declined as they maintain their presence by creating IRAs to oversee and regulate the sector. The design and creations of IRAs which were influenced by the literature on central bank independence, credible commitments of governments and political uncertainties (e.g., Rogoff, 1985; Thatcher, 2002), were motivated by the desire to insulate policies from future political interference, signal the credibility and commitments of reforming governments' to end self-regulation as well as replace political considerations by economic concerns (Estache et al., 2009; Pearce, 2006; Jamasb et al., 2004).

Therefore, IRAs are expected to protect private investors from the whims of the state, and consumers seeking protection from the incentives of dominant firm to influence prices through exerting market power or by tacit collusion with others (Jamasb et al., 2015). The creation of IRAs does not entail complete abandonment of the role of government in the sector. Rather, it shifts this role towards regulation and away from service provision, subsidising or financing of the sector. Therefore, the main outcome of the refrom is a switch from self-regulation or politically regulated provision of electricity to private sector provision of service and regulation by IRAs without political interference and conflict of interests (Estache et al., 2009).

The creation of the IRAs has been a major aspect of the reforms in SSA countries. During the period covered by this study, more than 50% of the countries in the region have established IRAs. These countries were also major beneficiaries of private sector investments (Eberhard et al., 2016).

Table 1 shows the creation dates of the regulators in SSA. Performance of the regulators in the region has been mixed. For example, effective regulation has been credited with significant improvements in financial and operating performance of the privatised utilities (Eberhard et al., 2016). However, these contrast sharply with studies that argue that SSA countries continue to suffer socially and economically post the reforms, due to insufficient investment levels required to improve generation capacity and reliability of service, increase access rates, and reduce transmission and distribution losses (Aurial and Blanc, 2009; Eberhard et al., 2011; Ahlborg et al., 2015).

Table 1: SSA Countries with IRAs

SSA IRAs and Year of Establishment	
Year	**Countries**
1994	South Africa
1997	Zambia
1998	Cameroon, Cote d'Ivoire, Senegal
1999	Niger, Madagascar, Uganda
2000	Ghana, Mali, Namibia, Togo
2001	The Gambia, Mauritania, Rwanda, Tanzania
2003	Cape Verde, Congo Republic, Zimbabwe
2004	Lesotho, Mozambique
2005	Central African Republic, Nigeria, São Tomé and Príncipe
2006	Kenya
2007	Angola, Malawi, Swaziland
2009	Benin
2010	Burkina Faso, Gabon
2011	Burundi, Sierra Leone, Sudan
2012	Seychelles
2014	Ethiopia

Source: Eberhard et al. (2016) and updated with data from Foster et al. (2017), https://openknowledge.worldbank.org/bitstream/handle/10986/28853/WPS8235.pdf?sequence=1&isAllowed=y; and Cape Verde, Seychelles, and São Tomé and Príncipe regulatory agencies' websites: Agência de Regulação Económica, http://www.are.cv/index.php; Seychelles Energy Commission, http://www.sec.sc/; and Autoridade Geral de Regulação, http://www.ager-stp.org/index.php/pt/.

Although, these poor reform outcomes have been attributed to a number of factors,[4] some have linked them to the broader national and institutional context within which IRAs are embedded (e.g., Minogue and Carino, 2006; Berg, 2000). This is because the quality of political institutions, credibility and reliability of the judiciary, institutional norms, administrative capacity and related factors were noted to have the potential to shape the functions of IRAs (Dubash and Rao, 2007). For example, in the SSA context, Eberhard (2007) argues that the failures of IRAs to achieve their mandates may be linked to unpredictable and inconsistent regulatory policies which are usually the fallouts of unstable and changing policy environments in which they operate.

Similarly, Chang and Berdiev (2011), Pitlik (2008), Vowles (2008) and Bodea (2010) have noted that the degree of government fragmentation, institutional constraints, political strength and government authority can induce governments to reverse or change previous enacted policies such as commitment not to interfere in regulatory functions. For example, in Uganda, the electricity regulatory authority was routinely harassed by the government, summoned and questioned before the Parliament (although not accountable to the Parliament) for increasing electricity tariffs and investigated by the police (Kapika and Eberhard, 2013).

This shows that even though the regulators in the SSA are independent and have desire to improve efficiency and access rates, their regulatory powers can be undermined by the institutional environment in which they operate. Thus, institutions which consist of formal and informal rules and norms (North, 1990) may determine the incentives of governments not to interfere with regulatory functions. However, the main institutional factor identified by most studies, were political interferences in regulatory functions. Implementation of reforms in SSA was heavily influenced by domestic political dynamics and citizens expectations of state provision of electricity (Gore et al., 2018). Also, governments tend to fill positions in the regulatory agencies with political and financial allies to keep electricity prices low and to incentivise poor voters (Estache and Wren-Lewis, 2010). Karekezi and Kimani (2002) find examples of this in Kenya, Malawi, and Uganda.

Therefore, in order to understand the performance of the regulators in the region, the focus should not only be on technical aspects of regulation such as tariff setting methodologies and their implementations, but also on contextual factors such as the political environment in which IRAs operate. This has led many studies to examine how political institutions influence the functions of IRAs in the sector (Imam et al., 2019; Chang and Berdiev, 2001; Cubbin and Stern, 2006; Erdogdu, 2013; Nepal and Jamasb, 2012b). These studies find evidence that political factors impact regulatory decisions which in turn affect regulatory outcomes. Although, there are several reasons (e.g., redistribution and economic development) why politicians intrude into IRAs' functions, however, the most widely cited is the need to correct market failure and enhance citizens' welfare (Munger, 2008).

[4] See World Bank (2017), Ahlborg et al. (2015), Eberhard et al. (2011), Sokona et al. (2012), and Khennas (2012) for details on these factors.

However, studies such as Pitlik (2007) suggest that although government interference may have detrimental effects, some regulation and public intervention is needed for a well-functioning economic system. Notwithstanding these conflicting arguments, a vast literature has emerged to show how governments based on ideological orientations of their political parties interfere in regulatory functions and influence outcomes (e.g., Benoit and Laver, 2006; Bjørnskov and Potrafke, 2011; Duso, 2002). Similarly, other studies specific to the energy sector have shown how energy regulators function under different institutional settings such as under different government ideologies (e.g., Pitlik, 2007; Potrafke, 2010; Hibbs, 1977; Alesina, 1987). For example, analysis of political economy of energy reforms in developing countries have noted that consumer opposition to energy price increases often forces governments to reverse their earlier policy commitments. Apart from consumer resistance to price increases, political opposition to reforms in developing countries was often backed by ideological arguments (Dorman, 2014). This is because political parties tend to promote economic policies in conformity with the ideology of their government (Hibbs, 1977; Chang and Berviev, 2011). Moreover, giving in to pressures from international multilateral organisations to transfer policy making powers to IRAs could depend on politicians who are more or less inclined towards the ideological orientations of their political parties. Therefore, government ideology may affect the functions of IRAs in SSA because it could determine government perceptions about these functions.

In this regard, the right-wing ideologies are mostly associated with policies aimed at protecting private property, deregulation, and privatisation which are all aimed at expanding the free market ideology. This has been supported by studies such as Pitlik (2007), Potrafke (2009) and Duso (2002), which show that liberalisation, deregulation, and privatisation policies are pursued by right-wing governments. In other words, right-wing governments promote economic freedom and prefer minimum government involvement in the economy, while left-wing governments are more likely to pursue social regulation to protect citizens from exploitation (Chang and Berdiev, 2011). Serrallés (2006) argues that the promotion of neoliberal economic ideologies mounted pressure on the monopolistic European electricity sector to implement reforms. The third consecutive general election victory for Thatcher government in 1987 contributed to the liberalisation and restructuring of state-owned electricity utilities in the United Kingdom (Damsgaard, 2003). As an opposite example, in Finland, where energy policy formulation and implementation have been dominated by the Centre Party and the Social Democrats, the production and import of electricity has been highly controlled and regulated by the government (Chang and Bendiev, 2001).

Therefore, in view of recent scepticisms towards neoliberalism and multilateral bodies, it is useful to analyse the political economy of reforms and their outcomes in the SSA region. Some argue that, politics in SSA countries are not driven by government ideology, rather by institutional factors such as corruption, political instability, and ethnic fractionalisation. For example, Mkandawire and Soludo (1999) and van de Walle (2002) argue that failures to implement reforms such as ESR, stalemates of reforms - where they have been initiated - or to attract private investments will not be explained by government orientations in SSA towards capitalism or socialism, self-reliance policies or globalisation. Similar, Erdogdu

(2014b) argue that there are no association between 'left'- or 'right-wing governments and any aspect of ESR among countries that are not members of the OECD.

Although, these arguments related to the weak governance have received attention, the main argument against the reforms in the region can be traced to government ideologies about the role of the state in the economy. After gaining independence, many SSA governments advocated comprehensive ownership of means of production and concerted efforts were made towards centralised economic management. For example, the Nkrumah government in Ghana pushed for the nationalisation of gold mines, while in Zambia the government took over the copper mines. Angola, Mozambique, Ethiopia, and Malawi adopted pure Marxism as form of government (Stambuli, 2002). The SSA countries confronted with the debt crisis of the 1980s, were advised by the World Bank and the IMF to restructure their economies prior to the extension of financial support. The Structural Adjustment Programmes required them to reduce the role of government in the economy through privatisation and competition. There was widespread opposition towards such conditionalities seen as a neoliberal agenda (Nwagbara, 2004). Similarly, the vertically-integrated nature of South Africa's electricity sector despite ESR, has been attributed to government focus on social imperatives; lack of regulatory and policy certainty; and conflicts in political ideology (Khan et al., 2016).

Furthermore, some case studies of ESR in SSA countries highlight that ideology is an important factor in countries of the region. Gore et al. (2018) find in Uganda, Tanzania, and Ghana, citizen expectations for the state to provide electricity were a significant factor that constrained ESR implementations. Despite these debates, and their tendency to shape the current political landscape as well as implementations of ESR, there is little evidence on how government ideology may have influenced the performance of electricity sector reforms through regulatory decisions. The above studies do not investigate the ideological differences in the impact of IRA on electricity sector performance. While IRAs are expected to increase efficiency, generation capacity, and expand access to service in SSA, the expected performance improvements of IRAs may be larger in some countries, especially in those with truly independent IRAs. While some of the reviewed studies treat IRAs and other institutional variables as exogenous (e.g., Estache et al., 2009), we treat these variables as endogenous, and use an Instrumental Variables (IV) estimator to investigate the impact of regulation and ideology on two indicators of electricity sector performance.

2.1. Hypotheses

The preceding subsection described how ideological orientations of governments could not only influence the creation of IRAs but also their subsequent credibility, independence, and performance. We formulate three hypotheses to test whether SSA countries have upheld the independence of IRAs or interfered in their functions to advance ideological objectives and the implications of this on the generating capacity and access rates. We expect right-wing governments to be more inclined towards creating credible, independent, and effective IRAs since they favour the protection of property rights, and legal equality as attributes of market economies. This is because implementation of electricity reforms entails reducing the reach of the government in the sector and introduction of market competition, thus it is more compatible with the ideological orientations of right-wing governments that tend to favour

smaller size of governments. Although, right-wing ideology is widely associated with the freedom of choice and protection of property rights, the successful implementation of the reform model in Chile shows that ideology can also thrive under authoritarian regimes even though it is difficult for such regimes to make commitments due to time-inconsistency problem (McGuire and Olson, 1996). Therefore, SSA countries regarded as dictatorships are also capable of implementing reforms like their democratic counterparts. Thus, since building large-scale transmission and distribution infrastructures and extending them towards poor areas is costly (Ahlborg et al., 2015), we expect the benefits of having access to affordable and reliable electricity by low income households to be limited under right-wing governments since the ideology tends to be driven by economic motives. This observation brings us to the first hypothesis:

H1: *Governments associated with right-wing ideologies would create credible and effective IRAs to promote economic regulation thereby increasing the installed generation capacity but not the access rates to the service.*

Gilardi (2008) show that due to the pressure to make creditable commitments not to adopt interventionist policies post reforms, left-wing governments would create independent regulators and liberalise markets. Thus, the creation of IRAs by left-wing governments can be seen as a commitment device since they are more likely to pursue policies aimed at protecting consumers. In contrast to right-wing governments which aim to pursue economic regulation, left-wing governments tend to pursue social regulation. However, extending services to those without access will also depend on increasing the capacity of utilities. Therefore, left-wing governments will also have incentives to support investments to increase capacity. Although left-wing governments have incentive to promote social regulation aimed at protecting citizens from the consequences of liberalisation (Ennser-Jedenastik, 2016; Hawkins and Hutler, 1993), they may also promote regulation especially when the interventions could fulfil their social objectives. This leads to the second hypothesis:

H2: *Left-wing governments may interfere with IRA functions to increase both generation capacity and access rates.*

Although, some governments in SSA are observed to be inclined either towards the left or the right in the dataset compiled by Cruz et al. (2016), there are other SSA governments that do not easily fit into neither of the two wings. In other words, such government policy objectives consist of ideologies of the two competing wings, focused on strengthening private enterprise in a social-liberal context and hence party platform does not focus exclusively either on economic or alternatively on social issues. We categorise these group of countries as having centrist governments based on the definitions in Cruz et al. (2016)[5] on government ideology. Thus our final hypothesis is:

H3: *There will be uncertainty on IRA's credibility, when there are competing wings in the government or governments that do not have clear economic or social objectives thus performance may improve or deteriorate.*

[5] For definitions and categorisations of government ideology, see Cruz et al. (2016).

3. Methodology

3.1. Econometric model

In order to analyse the effects of political ideologies and IRAs on performance, we specify and estimate an econometric model. We postulate that electricity sector performance (*esp*) depends on a dummy that indicates whether an independent regulatory agency exists in country *i* at year *t*, and a vector of control variables (*x*). In order to capture the ideological differences on the performance of IRAs (*ira*), we include two ideology dummy variables – left-wing (*left*) and right-wing (*right*) – that are additionally included interacting with *ira* as regressors. The comparison group consists of the countries in the sample we categorised as centrist governments. The coefficients of these variables show the effect of ideological differences on electricity sector performance. The performance model we estimate is presented in (1):

$$esp_{it} = \alpha_i + \beta_1 ira_{it} + \beta_2 left_{it} + \beta_3 right_{it} + \beta_4 (left_{it} \cdot ira_{it}) + \beta_5 (right_{it} \cdot ira_{it}) + \sum_{q=1}^{Q} \beta_{6q} X_{it} + \varepsilon_{it} \quad (1)$$

where *esp* is the performance indicator reflecting either of the two performance indicators: total installed capacity and access to electricity (i.e., access rates, *access*). βs are parameters to be estimated, α_i are country-specific effects and control for time-invariant unobservables and $\varepsilon_{it} \sim N(0, \sigma^2)$, is the stochastic error term. The vector *x* of control variables includes GDP per capita, total electricity generation, the size of electricity markets and corruption. Also, included as controls are two dummy variables indicating whether a country has privatised its utilities and has opened its electricity sector for private investments, and has unbundled its electricity sector.[6]

3.2. Estimation strategy

Using the pooled Ordinary Least Squares (OLS) estimator to estimate the parameters of Equation 1 yields inconsistent and unreliable results for two reasons. First, due to the presence of endogenous variables such as corruption (*corr*) and GDP per capita (*gdpper*), and second, the likely correlation between country-specific factors (captured by α_i) such as history, colonisation, and culture, and other regressors. This issue could be addressed by using a Fixed Effects (FE) estimator to ameliorate the bias arising from unobserved heterogeneity and endogeneity of regressors. An issue is that most indices and dummy variables in the model have little variation over time, which may lead to large standard errors of the coefficient estimates if an FE estimator is utilised. The Random Effects (RE) estimator is not appropriate either because, as noted, the regressors are likely to be correlated with unobserved country-specific factors.

[6]This consists of four types of private sector investments in power sector utilities of SSA namely management and lease contracts, brownfield, greenfield projects, and divestures.

Apart from the sources of endogeneity, reform performance equations tend to be represented as dynamic (e.g., Imam et al., 2019; Jamasb et al., 2005; Wintoki et al., 2012). In other words, performance depends not only on the current values of the regressors, but also on their past values. The OLS, the FE, and the RE estimators cannot produce consistent coefficient estimates in the presence of endogenous regressors and dynamics. Instead we use a dynamic panel General Method of Moments (GMM) estimator proposed and developed in a series of studies (e.g., Holts-Eakin et al., 1988; Arellano and Bond, 1991; Arellano and Bover, 1995; Blundell and Bond, 1998). These studies, particularly Arellano and Bond (1991), proposed two estimators, the one-step and the two-step GMM. We use the two-step GMM estimator because it provides more efficient estimators over the one-step GMM estimator (Gyimah-Brempong and de Camacho, 2006).

The use of a dynamic panel two-step GMM estimator improves on both the OLS and FE estimators by allowing for the inclusion of country-specific effects (α_i) to account for time-invariant unobserved heterogeneity, and the current performance to be influenced by previous realisation of performance. Similarly, unlike Two-Stage Least Squares (2SLS) which relies on difficult and sometimes unreliable instruments, the Difference GMM (Diff-GMM) estimator relies on internal instruments contained within the panel. In other words, past values of the regressor and performance can be used as instruments, and this eliminates the need for external instruments. However, Diff-GMM estimator like the FE not only eliminates α_i, but also removes all time-invariant variables through differencing the model during estimation. As noted by Roodman (2008), Diff-GMM performs poorly in the presence of persistent processes because the lagged levels may convey little information on future changes. As a result, the estimator tends to produce inconsistent estimates since the differencing produces weak instruments.

Arellano and Bover (1995) and Blundell and Bond (1998) improved on the shortcomings of the Diff-GMM estimator and developed its variant, the System GMM (Sys-GMM) estimator which allows for the inclusion of time-invariant regressors, which would have otherwise disappeared in the Diff-GMM estimation. Thus, the estimator solves the problems of endogeneity of regressors and dynamics by treating the model as a system of equations in first differences and in levels. It does so by instrumenting the endogenous regressors by lags of their levels, while instrumenting those in the level equation with lags of their first differences. We use these advantages of dynamic panel System GMM estimator to obtain consistent estimates. This entails transforming Equation 1 into a dynamic panel specification where the lagged values of the two performance indicators (installed capacity and access rates) are included as additional regressors in (2):

$$esp_{it} = \varphi esp_{it-1} + \alpha_i + \beta_1 ira_{it} + \beta_2 left_{it} + \beta_3 right_{it} + \beta_4 (left_{it} \cdot ira_{it}) + \beta_5 (right_{it} \cdot ira_{it}) + \sum_{q=1}^{Q} \beta_{6q} X_{it} \quad (2)$$

where esp_{it-1} denotes the lagged value of performance, whilst φ is the parameter associated with that variable. All other variables and coefficients are defined as before. Using the dynamic System GMM estimator to obtain consistent and unbiased results depends on two

specification tests. The first is a Hansen test for overidentification restrictions which is a joint test of model specification and appropriateness of the instrument vector. Failure to reject the null hypothesis of the test indicates that instruments used in estimation are valid and the model is well specified. The second is Arellano and Bond (1991) test for serial correlation of the disturbances up to the second order. The appropriate check of the test for serial correlation (AR) relates only to the absence of second-order serial correlation, AR(2), since the first differencing induces first-order serial correlation, AR(1), in the transformed errors.

3.3. Data

Dependent variables

The dependent variables in our model are installed capacity (*cap*) and access rates (*access*). We measure generation capacity by total installed capacity and access rate by percentage of total population with access to electricity. There are several ways to measure both, none of which is ideal. We focus on these two indicators of performance, because for SSA governments to increase access rates and meet supressed demand, install capacity must grow by more than 10% annually (Eberhard et al., 2011). Therefore, we would expect reforms to increase generation capacity and access to affordable electricity. Data on annual installed capacity (*cap*) and access (*access*) were sourced from the United States Energy Information Administration (EIA), and the World Bank Development Indicators Database. Additionally, electricity consumption per capita (*comper*) has been used as dependent variable in one model presented in the Appendix. Data on total electricity consumption averaged by total population was obtained from the United Nations Energy Statistics Database, while the data on total population was obtained from the World Development Indicator Database.

Independent variables

Information on government ideology is sourced from Beck et al. (2001) database of political institutions and updated by Cruz et al. (2016) which classifies governments as either left-wing, right-wing, centrist, or lacking an ideology. The variable ranges between 0 and 3, where the value 1 represents right-wing governments, the value 2 represents centrist governments, 3 represents left-wing governments, and countries without ideology were coded as 0. We construct three dummy variables in order to reflect the three respective government ideologies of SSA governments.[7]

In addition to the government ideology index, we use the Freedom House measure of freedom ratings, which consists of the evaluation of a country's political rights and civil liberties, to check the robustness of our estimates. Freedom rating is the combined average of two ratings – political rights and civil liberties ratings. Countries with an average score from 1 to 2.5 are defined as free, countries with scores from 3 to 5 as partly free and countries with scores from 5.5 to 7 as not free. We use this classification to construct three dummy

[7] In the category of centrist governments we also include countries which lack ideology and countries without information on government ideology in the database.

variables[8] that reflect the level of political rights and civil liberties in SSA countries. It is generally accepted that human freedom or liberty is intimately related or interwoven with property rights which are mostly associated with right-wing governments. Conversely, countries with left-wing governments tend to implement policies that put property rights at risk thereby discourage private investments, innovation and beneficial risk taking. Therefore, strong legal protections for property rights are a necessary condition for attracting private sector investments to increase both generation capacity and access rates.

The data on the independent regulatory agencies (*ira*) is drawn from Eberhard et al. (2016) and updated with additional data from Foster et al. (2017), Cape Verde, Seychelles, and São Tomé and Príncipe electricity regulatory agencies' websites as indicated in Table 1. Following Jamasb et al. (2004), we create a dummy variable that takes value 1 to indicate the existence of an IRA and 0 otherwise. The existence of an IRA has been associated with improved electricity sector performance (Cubbin and Stern, 2006), while political institutions can influence and improve the performance of IRAs (see Nepal and Jamasb, 2015).

Control variables

We include corruption (*corr*) in the model since the implementation of ESR also entails reducing the corruption levels (World Bank, 2000) which are noted to have a significant impact on generating capacity of utilities and access (Estache et al., 2009). We use the control of corruption index obtained from Kaufmann et al. (2010) which is included in the World Bank Governance Indicator Database. The corruption index, which measures corruption in both public and private sectors, ranges from -2.5 (highly corrupt) to 2.5 (highly clean).

Summary statistics of the data used in our estimations are presented in Table 2. The summary statistics indicate that total installed capacity, access, and other variables vary greatly across the SSA countries in our sample. For example, there is a wide variation in the data on installed capacity with *cap* ranging from a low of 0.01 GW for Liberia in 2005 to a high of 46.12 GW for South Africa in the same year. Our sample therefore includes countries with high level of installed generation capacity as well as countries with very low levels of installed capacity.

In order to represent the demand side, we use two control variables. First, previous studies have shown that investments are needed to increase both the generating capacities of utilities and increases in access rates are largely dependent on level of economic development (Zomers, 2001; Ahborg et al., 2015). Thus, we include a measure of countries' GDP per capita (*gdpper*). Second, we include the percentage of population that lives in urban areas (*urban*) as a proxy for size of electricity markets. The data on both variables were obtained from World Bank Development Indicators Database.

[8] The intuition for this is that freer societies are mostly associated with *laissez faire* policies aimed to reduce the role of the state in economic affairs and thereby avoid interfering with individual freedom. Moreover, Erdogdu (2013) argues that ESRs have been more extensive in countries with more investment freedom.

Table 2: Summary Statistics of the Data

Variables	Labels	Unit	Obs.	Mean	Std. Dev.	Min.	Max.
Dependent Variables							
Access Rates	*access*	%	720	33.17	23.86	0.01	99.4
Installed Capacity, Total	*cap*	GW	720	1.76	6.49	0.01	47.44
Elect. Consumption, Total	*comper*	GWh	716	356.22	659.32	1.61	4,187
Independent Variables							
Regulator	*ira*	Dummy	720	0.57	0.50	0	1
Centrist governments	*centre*	Dummy	696	0.65	0.48	0	1
Left-wing governments	*left*	Dummy	696	0.25	0.43	0	1
Right-wing governments	*right*	Dummy	696	0.10	0.30	0	1
Partly free governments	*pfree*	Dummy	720	0.45	0.50	0	1
Not free governments	*nfree*	Dummy	720	0.33	0.47	0	1
Free governments	*free*	Dummy	720	0.16	0.37	0	1
Control Variables							
Privatisation	*priv*	Dummy	720	0.57	0.50	0	1
Structure	*struc*	Dummy	720	0.10	0.30	0	1
Elect. Generation, Total	*gen*	GWh	720	8,439	36,139	21.68	263,479
Corruption	*corr*	Index	675	-0.64	0.59	-1.77	1.22
Ethnic fractionalisation	*ethnic*	Index	720	0.67	0.22	0	0.93
Conflict	*conflict*	Index	720	0.57	1.45	0	7
Ruggedness	*rugged*	Index	720	1.26	1.59	0.15	6.66
Latitude	*lat*	Degrees	720	0.01	14.21	-29.58	20.26
GDP, Per Capita	*gdpper*	2010 US$/Inhab.	701	2,005	2,954	193.87	20,334
Population Density	*popden*	Inhab./km^2	716	86.23	118.35	2.31	621.97
Urbanisation	*urban*	%	716	38.63	16.60	8.25	88.12
Population Growth	*poprate*	%	716	2.56	0.84	0.13	5.54

Note: *access*, *cap*, *comper*, *gen*, *gdpper* and *popden* were log-transformed prior to estimation.

On the supply side, we include total electricity generation (*gen*) and two ESR variables, privatisation (*priv*) and structure of the electricity market (*struc*). Data on *priv* was obtained from the World Bank Infrastructure Database. Data on *gen* is sourced from United Nations Energy Statistics Database, while data *struc* of the electricity market is from Foster et al. (2017). The database is composed of annual observations for a sample of 45 SSA countries for the period 2002-2015.[9] For robustness checks of our results, we add two each of institutional variables (ethnic fractionalisation and conflict), topographical variables (ruggedness and latitude) and demographic variables (population density and population growth) to both installed capacity and access rates equations. For data sources, descriptions of these variables as well as the results of the robustness tests see section 4.3.

4. Results

This section presents the coefficient estimates of the installed capacity and access equations using the dynamic panel Sys-GMM estimator. The first subsection discusses the estimates of the installed capacity equation while the second subsection discusses the estimates of access equation. We then report three robustness tests of our results. The regression statistics presented at bottoms of all results tables indicate that the models fit the data well. Arellano and Bond (1991) tests for serial correlation, AR(1) and AR(2), indicate that there is first order serial correlation, but not at the second order, which shows the inconsistency of OLS and the appropriateness of using a GMM estimator in this analysis (Arellano and Bond, 1991). In addition, Hansen's test of model specification and overidentifying restrictions indicates that the models are correctly specified with appropriate instruments. Failure to reject the null hypothesis of the test indicates that the instruments used in estimation are valid and the model is well specified.

4.1. Total installed generation capacity

The results of the two-step Sys-GMM estimates of the installed capacity are presented in Table 3. The coefficient of *ira* is positive and significant indicating that, all things being equal, the establishment of an IRA is positively correlated with improvements in generation capacity. This is in line with results obtained by several other studies (Cubbin and Stern, 2006; Nakano and Managi, 2008). This is consistent with Eberhard et al. (2016) observation that countries that established IRAs (Cameroon, Côte d'Ivoire, Ghana, Kenya, Nigeria and Uganda) were able to increase installed capacity by attracting new IPPs compared to countries without IRAs. However, this result contrasts with results obtained by some studies

[9] SSA countries in the sample are: Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Dem. Rep. Congo, Rep. Congo, Cote d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zambia, and Zimbabwe. Countries contained in the sample were dictated by data availability especially data on ideology.

(Nagayama 2010; Zhang et al., 2008) on the effects of IRAs on installed capacity. Our results support the view that IRAs help mitigate or insulate IPPs from investment risks especially when investing in weak institutional environments. For example, the Energy Regulatory Commission of Kenya helped reduce the power purchase agreement charges radically between the first set of IPPs negotiated and the second (Eberhard and Gratwink, 2011).

The coefficients of both *left* and *right* are not significant suggesting that, the effect of the two government ideologies on installed capacity are not different from that of centrist governments in SSA countries. The coefficient of *priv* is positive and significant indicating that privatisations of hitherto state-owned utilities and other forms of private participations have increased generation capacity. This is consistent with Eberhard et al. (2016) observation that private utilities post reforms, account for more than 25 percent of SSA countries' total installed generation capacity. Moreover, other empirical studies have also found private sector investments in electricity sector are positively correlated with performance improvements (Cullmann and von Hirschhausen, 2008; Zhang et al., 2008; Megginson and Netter, 2001; Nagayama, 2010). However, our result contrast with other studies that find IPPs and other forms of private sector participation have no impact on generation capacity (e.g., Bonifaz and Santín, 2000).

Table 3: Two-step GMM Estimates of Total Installed Capacity Equation

Total Installed Capacity (ln *cap*)		
Variable	**Est.**	**t-stat.**
ln *cap (t-1)*	0.910***	42.68
ira	0.261***	5.41
left	-0.021	-0.32
right	-0.152	-1.11
priv	0.141***	2.88
struc	-0.597***	-3.37
iraXleft	-0.195***	-2.61
iraXright	0.343**	2.27
corr	0.200	1.24
ln *gdpper*	0.111*	1.68
urban	-0.002	-0.72
intercept	-0.764*	-1.76
No of obs.		590
No of countries		45
Instruments		42
AR(1) test (p value)		-2.46 (0.014)
AR(2) test (p value)		0.88 (0.381)
Hansen test (p value)		26.80 (0.634)

Significance code: *** p<0.01, ** p<0.05, * p<0.1

The coefficient of *struc* is negative and significant, indicating that structure of electricity sectors especially the unbundling of the hitherto state-owned utilities have negatively affected generating capacity of utilities. This may indicate that in the five countries that unbundled their electricity markets in SSA, it could be that system operators are grappling with the complexities of coordinating generation and transmission post reforms. Our result contrast with Nepal and Jamasb (2012b) who find that reform measures such as unbundling did not result in efficiency improvements in the sector and Nagayama (2010) who finds that key reform measures (i.e. unbundling, IPPs investments, and establishment of IRAs) has led to improved efficiency.

The coefficients of *corr* and *urban* are both not significant indicating that, corruption and size of electricity markets has no statistical impact on generation capacity. These estimates especially on corruption, contrasts with those obtained by Imam et al. (2019), Wren-Lewis (2013) and Estache et al. (2009) for technical efficiency. However, this may be explained by the choice of installed capacity as dependent variable. This is likely because electricity generating utilities, especially IPPs, seeking to mitigate investment risks while operating in weak institutional environments such as in SSA countries, often sale their electricity output to off-takers or require sovereign and World Bank guarantees thereby effectively insulating them from corruption. The coefficient of *gdpper* is positive and significant indicating that income has positive impact on the installed capacity of the sectors.

Are there government ideological differences in efficiency impact of IRAs? The answer is provided by the coefficient estimates of the two interaction terms. The coefficient of *iraXleft* is negative and significant, suggesting that installed capacity impact of IRAs in countries with left-wing governments is lower than impacts of IRAs in countries with centrist governments. This result is in line with the results obtained by earlier studies that showed the adverse effects of left-wing governments on regulation (e.g., Pitlik, 2007; Bjørnskov, 2005) and thus regulatory outputs. The coefficient of *iraXright* is positive and significant, implying that the generation capacity effect of IRAs is larger in countries with right-wing governments than those with centrist governments. This result is in line with Potrafke (2010), Bortolotti et al. (2003), and Bortolotti and Pinotti (2008) who noted that right-wing governments favour the independence of IRAs to promote their economic objectives.

The coefficients of the interaction terms reinforce the arguments of the World Bank (1993) and Megginson and Netter (2001) on how interventionist policies such as government financed provision of electricity and sheltering of utilities from competition is less efficient than services provided by private utilities in competitive electricity markets. This is because countries with institutionalised protection of property rights and rule of law[10] (Acemoglu and Robinson, 2012) are mostly countries that attract private investments in the form IPPs and can increase generating capacity (Eberhard et al., 2006). In SSA countries with history of interventionist policies, aversion to neoliberal reforms or with leaders who can effectively use state institutions to reward loyalists or punish foes, less ESR have been implemented (van de Walle, 2001) and direct government regulation of the sector exist.

[10] Mostly associated with right-wing governments.

The interactions coefficients suggest that we reject Hypothesis 2 and conclude that left-wing ideologies by interfering with IRAs' functions have led to lower generation capacity in SSA during the period of our study. And we fail to reject Hypothesis 1, which suggests that right-wing governments promote IRAs' independence and thus have increased generation capacity. These two coefficient estimates indicate that there are significant differences in terms of ideology in generation capacity effects of regulators. We therefore reject the proposition that there are no ideological differences in the generation capacity of IRAs.

4.2. Access to electricity

There are conflicting arguments in the literature on the definition of access rates.[11] For example, Min (2008) use share of population in unlit areas based on analyses of satellite night time images, while Ahlborg et al. (2015) and Estache et al. (2009) have used electricity consumption per capita and kilograms of oil used per capita as indicators of electricity access rates. Notwithstanding the conflicting choice of indicators by these researchers, we have used the percentage of total population of a country with access to electricity services as dependent variable in the access equation. However, we have also presented the estimation results for electricity consumption per capita in the Appendix.[12]

The coefficient of *ira* is positive and significant suggesting that, that SSA countries that have established IRAs have increased access rates. This result confirms the result obtained by Imam et al. (2019) on the positive impacts of SSA countries' IRAs on access improvements and World bank (2017) report that show how Rwanda's electricity regulator (RURA) by overcoming regulatory risks that inhibit electrification efforts, was able to reduce connection costs and increased access rates from 6 percent in 2008 to 16 percent in 2012.[13] Similar findings were established by studies on other developing countries. For example, Cubbin and Stern (2006), Erdogdu (2014) and Zhang et al. (2008), find regulatory governance as result of power sector reforms have not only expand generation capacity expansion, utilisation of generation capacity and reserve margin, but also enhanced service penetration.

The coefficient of *right* is negative and significant suggesting that access to electricity is lower in countries with right-wing governments than countries with centrist governments. This result is consistent with the arguments that right-wing governments provide less for basic needs (Moon and Dixon, 1985) and prefer minimum government involvement in the economy (Chang and Berdiev, 2011). The coefficient of left is not significant indicating that access rates effects of left-wing governments are not different from that of countries with centrist governments. The coefficient of *priv* is negative and significant suggesting that privatisation of utilities and other forms of private participation have led to reduction in access rates. This result is consistent with other findings that how privatisation policies have led to access rates reductions (Bhattacharyya, 2006; Sihag et al., 2007) and to concentration of services to profitable areas in SSA countries (Victor, 2005).

[11] See Ahlborg et al. (2015), Min (2008), and Doll and Pachauri (2010) on choice of access indicators.
[12] The results in the Appendix confirm the estimates of the access equation presented in Table 4.
[13] This was achieved in conjunction with Electricity Sector Wide Approach (eSWAp) policy of Rwanda.

Table 4: Two-step GMM Estimates of Access Rates Equation

Access Rates (ln *access*)		
Variable	**Est.**	**t-stat.**
ln *access (t-1)*	0.727***	107.11
ira	0.094***	3.22
left	0.004	0.23
right	-0.121***	-2.58
priv	-0.039***	-3.25
struc	-0.020	-0.76
iraXleft	-0.115***	-4.27
iraXright	0.083	1.62
corr	0.042	1.23
ln gdpper	0.090***	7.00
ln gen	0.034***	4.80
urban	0.004***	4.30
intercept	-0.067	-0.97
No of obs.		590
No of countries		45
Instruments		43
AR(1) test (p value)		-2.51 (0.012)
AR(2) test (p value)		-0.10 (0.920)
Hansen test (p value)		33.02 (0.322)

Significance code: *** p<0.01, ** p<0.05, * p<0.1

The coefficient of *struc* is not significant suggesting that unbundling of electricity sectors of SSA countries have no effect on access. The coefficients of *gdpper*, *urban* and *genper* are all positive and significant indicating that per capita income, the size of electricity markets and electricity production have all boosted access to electricity services in SSA countries during the period covered by our study. This is because post reforms implementations, increased income level, expansion of transmission and distribution networks, and electricity generation especially by private utilities have helped expand the electricity supply capacity and thus enhanced access to electricity (Jamasb et al., 2016).

The coefficient of *iraXright* is not significant, suggesting that the access rates effect of IRAs in SSA countries with right-wing governments is not different from that of SSA countries with centrist governments. However, the coefficient of the interaction term *iraXleft* is negative and significant. This indicates that, the access rate impact of IRA in SSA countries with left-wing governments is lower than those of countries with centrist governments. This result suggests that ideologically motivated interventions especially by left-wing governments in regulatory functions have constrained the efforts of IRAs to incentivise utilities to increase access rates. In fact, a significant number of SSA countries' electricity utilities well-documented failures to extend services to the millions without access has been blamed on inappropriate regulation and government intrusiveness, rather than effectiveness

of ESR (Kipaki and Eberhard, 2013; Eberhard et al., 2016). These two estimates entail the rejection of Hypothesis 1 and Hypothesis 2 which postulated that interference in the regulatory functions by left-wing governments increases access rates while by right-wing governments has access reducing effects.

Moreover, these estimates contrast with the ideas presented by some theoretical works (e.g., Gilardi, 2005; Hawkins and Hunter, 1993) that left-wing governments place more weight on social issues (e.g., access to electricity by the poor) and thus interfere in the IRAs functions to promote social regulation. Similar arguments were put forward on the effects of right-wing governments. For example, right-wings governments associated with promotion of competition and preventing dominant firms from abusing market power (Ennser-Jedenastik, 2016), are also expected to increase social welfare indirectly through these policies. Our results did not live up to the expectations of these theories and indicate that there are significant differences in access rates effects of political ideologies.

4.3. Robustness test

It is possible that our obtained results on installed generation capacity and access rates impacts of IRAs and ideologies are affected by omitted variable bias or choice of the ideology variable. Hence, in this subsection we test the robustness our estimates of the two performance indicators. We begin by adding six addition regressors (two each of demographic, institutional, and topographical variables), two at a time, to both to the installed capacity and access rates equations to see if this would significantly change the coefficient estimates of the two interaction terms. We then estimate the two equations by using an alternative of measure of ideology (Freedom Index) to see if our results are driven by the choice of the institutional index used.

4.3.1. Additional regressors

Min (2008) argue that physical geography of a country and countries at higher absolute latitude influences investments in electricity infrastructure needed to extend services especially to those in rural areas. Excluding these two variables from the performance equations could, potentially, lead to biased coefficient estimates of the effects of IRAs and government ideologies on installed capacity and access rates. We therefore use ruggedness (*rugged*) and latitude (*lat*) as additional regressors in the two performance equations. *Rugged* is measured in hundreds of meters of elevation difference for grid points 30 arc-seconds (926 meters on the equator or any meridian),[14] while *lat* is expressed in decimal degrees, for the geographical centroid of a country. Data on both variables were obtained from Nunn and Puga (2012).

Other studies have argued that ethnic fractionalisation and civil wars and conflicts are among the major challenges facing efforts to increase infrastructure investments and increase access

[14] However, the measure used in this paper is an index which gives more weight to densely populated areas.

to electricity services (Min, 2008; Ahlborg et al., 2015). We therefore an include index of conflict which is the total summed magnitudes of both societal and interstate conflicts (*conflict*), and a time-invariant ethnic fractionalisation (*ethnic*) index to the two performance equations. These two variables are obtained from Alesina et al. (2003) and Marshall (2017) respectively.

Finally, several studies find population density (*popden*) and growth rate of population (*poprate*) to have effects on electricity sector performance (Erdogdu, 2012; Imam et al., 2019; Eberhard et al., 2016). We therefore add annual population density, which is in people per square kilometres of land area and growth rate of total population. Data on *popden* is from the World Bank Development Indicators Database while data on *poprate* is from the United Nations, Department of Economic and Social Affairs, Population Division (2018).

The results of the robustness test are presented in Tables 5-6. Columns 1, 3, and 5 in both tables present the coefficient estimates of *iraXleft*, *iraXright* and the rest of the variables when the six variables divided into 3 different sets are included as additional regressors in the capacity and access equations. Coefficients of the dummy interactions remain significant and with the same signs regardless of the additional regressors we included in the two equations. The coefficient of *ira* also remain significant and with the same sign. The estimates suggest that the ideology dummy variables are not acting as proxies for some omitted regressors which should have been included in the global performance equations.

Table 5: Two-step GMM Estimates of Total Installed Capacity Equation

Installed generation capacity (ln *cap*)						
	rugged + latitude		***ethnic + conflict***		***popden + poprate***	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Variable	**Est.**	**t-stat.**	**Est.**	**t-stat.**	**Est.**	**t-stat.**
ln *cap (t-1)*	0.923***	45.09	0.911***	43.27	0.644***	9.68
ira	0.258***	6.92	0.415***	5.62	0.846**	2.08
left	0.026	0.45	0.056	0.86	0.070	0.25
right	-0.180	-1.49	0.010	0.09	0.075	0.16
priv	0.096***	2.91	0.134***	3.07	0.235*	1.66
struc	-0.378**	-2.26	-0.984***	-4.10	-2.765***	-3.26
iraXleft	-0.239***	-3.59	-0.371***	-4.39	-0.625*	-1.79
iraXright	0.192*	1.87	0.415*	1.90	1.581**	2.46
corr	0.275*	1.67	0.210*	1.95	0.335**	2.39
ln *gdpper*	0.125**	2.24	-0.059	-0.62	-0.414*	-1.75
urban	-0.003	-1.11	0.002	0.48	0.017	1.61
rugged	-0.028	-1.36	-0.009	-0.52	0.005	0.04
lat	0.003	1.36	-0.003	-1.11	-0.030*	-1.92

ethnic			0.329	1.31	2.607*	1.91
conflict			-0.030**	-2.06	0.013	0.58
ln *popden*					0.091	1.10
poprate					-0.153	-1.41
intercept	-0.710*	-1.89	0.020	0.03	0.043	0.03
No of obs.		590		590		590
No of countries		45		45		45
Instruments		44		40		39
AR(1) test (p value)		-2.45 (0.014)		-2.48 (0.013)		-2.37 (0.018)
AR(2) test (p value)		0.90 (0.366)		0.76 (0.444)		-0.29 (0.771)
Hansen test (p value)		25.90 (0.680)		23.32 (0.501)		18.02 (0.648)

Significance code: *** p<0.01, ** p<0.05, * p<0.1

Table 6: Two-step GMM Estimates of Access Rates Equation

Access rates (ln *access*)						
	rugged + latitude		***ethnic + conflict***		***popden + poprate***	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Variable	**Est.**	**t-stat.**	**Est.**	**t-stat.**	**Est.**	**t-stat.**
ln *access (t-1)*	0.734***	83.60	0.705***	88.13	0.735***	56.22
ira	0.116***	3.01	0.060**	2.18	0.047***	2.63
left	-0.003	-0.13	0.020	0.84	0.069	1.61
right	-0.119*	-1.75	-0.093*	-1.84	-0.075*	-1.85
priv	-0.040***	-2.93	-0.004	-0.24	-0.020	-0.92
struc	0.032	1.31	0.026	1.00	0.181**	2.52
iraXleft	-0.109***	-3.11	-0.076***	-2.67	-0.150***	-3.17
iraXright	0.054	0.92	0.035	0.77	-0.065	-1.42
corr	0.114***	2.76	0.034	0.95	0.061	1.39
ln *gdpper*	0.072***	3.56	0.037	1.28	0.035	1.24
ln *gen*	0.024***	2.85	0.053***	5.78	0.061***	6.08
urban	0.005***	4.09	0.008***	6.10	0.007***	3.84
rugged	0.029***	2.58	0.012	0.64	-0.008	-0.72
lat	0.002**	2.11	0.005***	5.50	0.007***	6.96
ethnic			-0.525***	-4.14	-0.480***	-3.12
conflict			-0.013*	-1.84	-0.096***	-4.87
ln *popden*					0.010	0.81
poprate					-0.042***	-2.60
intercept	0.063	0.57	0.425*	1.94	0.446*	1.84

No of obs.	590	590	590
No of countries	45	45	45
Instruments	39	41	43
AR(1) test (p value)	-2.56 (0.010)	-2.53 (0.011)	-2.49 (0.013)
AR(2) test (p value)	-0.03 (0.975)	-0.02 (0.983)	-0.20 (0.839)
Hansen test (p value)	21.36 (0.618)	21.37 (0.617)	22.40 (0.555)

Significance code: *** p<0.01, ** p<0.05, * p<0.1

4.3.2. Alternative measure of ideology

Our results of the installed capacity and access estimations are based on the ideology index compiled by Beck et al. (2012) and updated by Cruz et al. (2018). It is possible that our earlier obtained results are driven by this choice of index. To analyse this possibility, we use an alternative institutional index – the Freedom House's freedom rating – to check the ideological differences in the performance impact of IRAs.

The results of the estimations of installed capacity equations and access rates using the Freedom House index as our alternative measure of ideology are presented in Table 7. The estimated coefficient of IRA is significant and positive in both estimations, thus confirming our earlier obtained results. The coefficient of the dummy interactions terms in both columns 1 and 2 remain significant and with the same signs regardless of the freedom rating used as a proxy for the ideology index in both two equations. In other words, these estimates suggest that freedom differences in the performance effects of *ira* we find in this section are similar to the ideological differences in the performance impact of *ira* we found above and thus our earlier results are not driven by the ideological index we use.

Table 7: Two-step GMM Estimates of Access and Installed Capacity Equations.

	Installed generation capacity		**Access rates**	
	(1)	**(2)**	**(3)**	**(4)**
Variables	**Est.**	**t-stat.**	**Est.**	**t-stat.**
ln cap (t-1)	1.020***	147.61		
ln access (t-1)			0.748***	161.63
ira	0.069***	4.03	0.147**	2.49
nfree	0.014	0.40	0.219***	3.96
free	-0.138***	-9.10	-0.134*	-1.65
priv	-0.032**	-2.39	-0.061***	-2.61
struc	-0.070***	-4.77	0.172***	6.80
iraXnfree	-0.053**	-2.09	-0.167***	-3.08
iraXfree	0.061***	4.85	0.029	0.35
corr	-0.024	-1.00	0.268***	5.18

ln gdpper	0.027	1.53	0.061*	1.74
urban	0.001	0.34	0.005***	3.70
ln gen			0.004	0.46
intercept	-0.133	-1.38	0.288	1.47
No of obs.		613		613
No of countries		45		45
Instruments		44		43
AR(1) test (p value)		-2.33 (0.020)		-2.97 (0.003)
AR(2) test (p value)		0.95 (0.344)		-0.37 (0.708)
Hansen test (p value)		31.70 (0.482)		29.80 (0.476)

Significance code: *** p<0.01, ** p<0.05, * p<0.1

5. Conclusions and policy implications

The common and important feature of electricity sector reforms in Sub Saharan Africa over the past two and half decades, has been the creation of independent regulatory agencies. These new institutional bodies were mandated to regulate and oversee the electricity market and look after consumer interest. IRAs were expected to depoliticise electricity price-setting and encourage private sector investment through transparent and predictable decisions. By fulfilling these regulatory tasks, IRAs were to increase the generating capacity and access to electricity services. Despite the anticipated performance improvements, there is some evidence that the region's electricity sectors are still bedevilled by low generation capacity, poor network infrastructure, and large group without access to services.

Numerous studies have linked the poor outcomes to factors such as historical, economic, financial, and corruption related factors. However, political economy factors have received less attention in the literature. For example, some studies have noted that, political ideology of governments may promote or constrain regulatory functions. Our paper focuses on the influence of political ideology on IRAs and their regulatory effectiveness. We use panel data and a dynamic panel data estimator to investigate ideological differences in the effects of IRAs on total installed capacity and access rates.

We find that IRAs have positive and significant effects on both generation capacity and access rates. We similarly find significant ideological differences in the effects of IRAs on installed capacity and access rates. The largest negative effects of the interactions between IRAs and ideology on installed capacity and access rates is found in SSA countries with left-wing governments. Our results are robust after controlling for additional variables and different measure of ideology that have impacts on electricity sector performance.

What policy implications can be derived from our results? All the SSA countries that have implemented ESR aimed to achieve certain level of economic development through increasing the productivity of their electricity sectors and access to electricity. Our results imply intrusion into regulatory functions especially by left-wing governments would lead

reductions in investments need to increase generation capacity and expand access rates since regulatory decisions would be viewed by investors as politicised. This means that countries with left-wing governments cannot expect large inflows of private sector investments or a stable and efficient electricity sector, all necessary conditions for achieving a higher and sustained level of economic development. The implication of our results is that countries with left-wing governments can increase the growth rate of income by taking steps to reduce interferences in IRAs functions because, because this will not only increase generation capacity, but would also lead to higher access rates.

The performance impact of IRAs is not uniform in all SSA countries. Therefore, while it may be necessary to strengthen the independence of IRAs in all SSA countries to signal credibility and attract the needed private sector investments to increase generation, expand transmission and distribution infrastructure and access rates, this may not equally pressing in all countries of the region. As noted, the need to reduce interference in regulatory functions to attract private sector participation into electricity generation and boost access rates is more pressing in countries with left-wing governments and countries with centrist governments than it is in countries with right wing governments.

Therefore, SSA governments with different ideologies should place differential emphasis on policies to strengthen the independence of IRAs as a means of improving efficiency and access rates. While strengthening the independence of IRAs in left-wing governments may be critical for increasing capacity and access rates, it may not be as critical for right-wing or centrist governments, especially in increasing capacity. Then giving more independence to IRAs or not interfering in their functions in SSA countries by the same proportion will not only improve increase capacity and access, it will also help narrow the gap among the countries with different ideologies, since SSA countries with low installed capacity and access rates will benefit the most by boosting the independence of IRAs.

These results should be interpreted with caution as the proxies for IRA and government ideologies do not reflect the degree, extent, or intensity of regulation nor the dynamics or incentives of governments. There is a need for further studies to investigate regime (e.g., democracy and autocracy) difference in the effects of reforms to enhance our understanding of the link between performance and politics as well as other institutional factors that may constrain regulatory functions and private investments.

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Appendix: A

Two-Step GMM estimates of consumption per capita equation

Table A1: Two-step GMM Estimates of Consumption per Capita Equation

Consumption per capita (ln *comper*)		
Variable	**Est.**	**t-stat.**
ln *comper (t-1)*	0.793***	10.43
ira	0.086**	2.14
left	0.045	1.05
right	-0.075	-0.68
priv	0.017	0.47
struc	-0.419***	-3.58
iraXleft	-0.070*	-1.94
iraXright	-0.006	-0.06
corr	0.038	0.72
ln *gdpper*	-0.279***	-2.99
ln *gen*	0.255***	4.64
urban	-0.003	-0.66
intercept	-1.602*	-1.65
No of obs.		590
No of countries		45
Instruments		37
AR(1) test (p value)		-1.87 (0.061)
AR(2) test (p value)		-0.66 (0.512)
Hansen test (p value)		23.37 (0.498)

Significance code: *** p<0.01, ** p<0.05, * p<0.1