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Governance, debt service, information technology and access to electricity in Africa

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Abstract

The study investigates the role of governance (i.e., 'voice & accountability', political stability/no violence, regulatory quality, government effectiveness, corruption-control and the rule of law) in the incidence of short-term debt services on infrastructure development in the perspective of telecommunication infrastructure and access to electricity. The focus of the study is on 52 African countries for the period 2002-2021. The generalized method of moments is employed as estimation strategy and the following findings are established. Debt service has a negative unconditional effect on access to electricity and telecommunication infrastructure. Governance dynamics moderate the negative effect of debt service on infrastructure dynamics. Effective moderation is from regulatory quality and corruption-control for access to electricity and from government effectiveness, regulatory quality, corruption-control and rule of law, for telecommunication infrastructure. Policy implications are discussed.

Keywords: Debt service, governance; information technology; access to electricity; Africa

JEL Classification: F34; H63; O10; O40; O55

1. Introduction

The focus on the present inquiry on linkages between governance, external debt service and infrastructure development in Africa is premised on two main motivational factors in the corresponding policy and scholarly literature on the subject, notably: (i) the growing crisis of debt in the South and corresponding ramifications for regional and continental stability and (ii) gaps in the extant policy and scholarly literature in the light of debates in the corresponding literature on the nexus between external debts and economic development prospects. The elements of motivation are substantiated in the following paragraph using the same chronology as highlighted.

First, consistent with the extant policy literature (Asongu & le Roux, 2023; Dieter, 2023), there is an evolving consensus on a growing debt crisis both for households and corporations in developing countries, especially as it pertains to growing external debt levels. According to the attendant literature, approximately 15% of countries in the low-income category are witnessing debt distress whereas about 45% of nations in the same low-income category are very likely to witness debt distress in the months ahead. The narrative maintains that the looming debt crisis is traceable to a plethora of factors which entail: (i) an alliance of Western-oriented economic and political sanctions and (ii) a development of dangerous nature from technically-advanced nations which are characterized by almost interest-rate free loans, especially in the organization for economic cooperation and development (OECD) countries. The underlying policy concern is further heightened by the scholarly debate on the nexus between external debt and economic development prospects.

Second, consistent with contemporary literature on the nexus between external debt and economic development (Manasseh *et al.*, 2022), the debate on the effect of external debt on economic prosperity is apparent owing conflicting empirical findings. Accordingly, while a strand of the literature argues that when properly utilized, external debts can boost income and productivity, another strand of the literature is of the perspective that, if external debt is not well channeled to optimal production avenues, it may instead retard economic prosperity owing to *inter alia*, liquidity constraints, overcrowding and debt overhang (Rockerbie, 1994; Joy & Panda, 2020). In essence, there is a strand of extant literature arguing for the position that external debt is negatively related to investment (Fosu, 1996; Hansen, 2001; Karogol, 2002; Clement *et al.*, 2003; Sandow *et al.*, 2022) and by extension, positing that drawback in investment retard economic prosperity as a result of external shocks. Moreover, as argued by Clement *et al.* (2003), growth risk may characterize a country that employs funds that are available for the service of debts instead of using the corresponding funds for the purposes of domestic investment.

Narrowing the perspective to Africa which is the focus on the present exposition, conflicting streams of the literature are still apparent. Positions for favorable (Elibadawi *et al.*, 1997) and unfavorable (Pattillo *et al.*, 2002) incidences of external debt on economic prosperity are still apparent (Manasseh *et al.*, 2022). It is relevant to further articulate that Manasseh *et al.* (2022) is the study in the extant empirical literature that is closest to the positioning of the present study. Accordingly, Manasseh *et al.* (2022) have investigated the effect of external debt on economic growth in sub-Saharan Africa (SSA). The underlying study has examined the relevance of governance in the effect of external debt on real economic prosperity. The authors have focused on a panel of 30 nations in SSA for the period 1997 to 2020 and the empirical strategy employed is the generalized method of moments (GMM) estimation approach. They have concluded that external debt is negatively linked to economic prosperity and thus, sampled countries should work towards reducing external debt as well as improving governance standards which is necessary for the favorable economic outcomes in terms of economic prosperity.

Compared to Manasseh *et al.* (2022), the present positioning provides insights into two main similarities as well as five principal distinctive features. On the similarity front, the role of governance is considered in both studies, not least, because governance is acknowledged as the moderator in the nexus between external debt and economic development outcomes. Moreover, the estimation techniques are the same, especially as it pertains to the employment of the GMM estimation approach. With respect to the distinctive features, five differences are worth articulating. (i) In terms of positioning, while the underlying study is concerned with the importance of governance on the linkage between external debt and economic prosperity, the present exposition is concerned about the connection between debt service and infrastructure development. (ii) The underlying study is concerned with SSA while this exposition focuses on Africa. (iii) While the problem statement is empirically understood within the remit of interactive regressions, the interactive regressions in the underlying study are poorly specified, not least, because constituents of the interactions are not involved in the corresponding specifications. The present exposition avoids the pitfalls of interactive regressions documented in Brambor *et al.* (2006) by involving constituents of the interactions in the specifications in order to avoid biased estimations. Moreover, the findings in the present exposition are not interpreted as in linear additive models in, because net effects of external debt on the outcome variable are computed. Such net effects entail both the unconditional and conditional or interactive estimated coefficients of external debt. (iv) With respect of the independent variable or channel of interest, while the present study is concerned about debt service, the underlying study has focused on external debt. (v) The reported post-estimation GMM diagnostic criteria of the underlying study are incomplete and hence, it is difficult to establish if the GMM models are robust or not. For instance, regarding the incomplete information criteria, the number of

instruments and corresponding number of countries are not disclosed in the underlying study. Moreover, year effects or time invariant impacts which are introduced in the GMM models to account for cross-sectional dependence as well as control for the unobserved heterogeneity are not apparent.

As articulated above, the rationale of considering governance, debt service, information technology and access to electricity can be summarized as follows: (i) debt service represents an important policy syndrome that is limiting available funds that should have been invested in infrastructure development (Asongu & le Roux, 2023; Dieter, 2023); (ii) governance is a policy or moderating variable through which debts can be effectively managed in order to boost infrastructural development (Manasseh *et al.*, 2022; Andrés *et al.*, 2015) and (iii) information technology and access to electricity infrastructure are some fundamental infrastructural dimensions that are essential for economic development in the sub-region (Nchofoung & Asongu, 2022; Nchofoung *et al.*, 2022). There is thus an acknowledgement that the primary problem of debt servicing is crowding-out investment which includes investment in information technology and access to electricity.

The remainder of the study is structured in the following manner. The theoretical underpinnings and testable hypotheses are provided in Section 2 while the data and methodology are covered in Section 3. The empirical results and corresponding discussion are disclosed in Section 4 while Section 5 concludes with implications and future research directions.

2. Theoretical underpinnings and hypotheses development

2.1 Theoretical underpinnings

Consistent with the extant literature, the theoretical underpinning of the study is consistent with the Debt Overhang Theory (Krugman, 1988; Manasseh *et al.*, 2022), especially in the light debt servicing. According to the attendant theory, when the probability of future debts is greater compared to the repayment probability of the country, unexpected costs are engendered which substantially have negative externalities on domestic investments. By extension, such domestic investments entail investments in infrastructure such as investment in telephone infrastructure and electricity access which are considered as outcome variables in this study. It is important to clarify that in terms of contextualizing the underlying theory to the positioning of the present study, two points are worth clarifying. On the one hand, short term external debt service is employed in this study as the main channel by which investment in infrastructure is affected. According to the attendant theory, when short term repayment ability cannot be met by the corresponding country, it engenders funding deficiencies in debt management as well as funding issues relevant to much needed infrastructure linked to information technology and electricity access.

In the light of the above, evidence that a nation can achieve economic growth can be viewed from two main perspectives. On the one hand, economic prosperity is the result of innovation dynamics which engender competition and correspondingly, investments which are funded by both the private and public sectors of the economy. This narrative is consistent with both the dynamic competition theory as well as the neoclassical growth theory (Ellig, 2001; Solow, 1956). In essence, Solow (1956) is of the perspective that policies that are tailored to support economic projects are founded on efficient allocation of funds from both the public and private sectors of the economy. Moreover, such funds should be sufficient and not be curbed by underlying issues such as insufficient tax mobilization and debt overhang. Since such funding can result from external sources, the corresponding external funding is obviously closely associated with debt service and attendant concerns such as debt overhang which is the theoretical premise of the present exposition. On the other hand, the Dual Gap theory is also apparent, not least, because in the absence of mobilized savings for domestic investment purposes in developing countries, such countries are constrained to rely on external sources of funding which are obviously associated with debt services and by extension, potential concerns surrounding debt overhang (McKinnon, 1964).

With respect to the Neoclassical economic growth theory, economic growth is positively associated with external debt. However, the theory also posits that, optimal allocation of funding from external sources is also worthwhile in order to mitigate potential concerns related to debt servicing, *inter alia* (Ellig, 2001). The present exposition takes this concern into account by engaging governance variables are possible moderators or policy

tools that can be employed to mitigate the potentially negative nexus between external debt service and economic development dynamics such as infrastructural development prospects. Contrary, the debt overhang theory posits that the positive and direct nexus between external debt and economic growth could be limited when more debt is incurred by the country under consideration such that debt service becomes a concern for the corresponding country as time unfolds. According to the narrative, this theoretical underpinning is consistent with the experience of most African countries in the 1970s. In essence, these countries borrowed huge external debts with the hope of funding infrastructure projects in view of generating employment and by extension, boosting economic growth and development. Unfortunately, most of the corresponding debt was not employed for productive investments (Elibadawi *et al.*, 1997; Fosu, 1999; Rodrik, 1999; Were, 2001; Karogol, 2002; Pattillo *et al.*, 2002; Audu, 2004; Onyekwelu & Ugwuanyi, 2004; Hameed *et al.*, 2008; Jayaraman & Lau, 2008; Adegbite *et al.*, 2008; Agbemavor, 2015). Many factors have been documented for the underlying efficiency, among which, is poor governance. This takes us to the next section, on the importance of good governance in moderating the incidence of external debt on economic development prospects.

2.2 Governance in the nexus between external debt and economic development

According to the narrative on the theoretical underpinnings covered in the previous section, , a scenario of debt overhang is more likely to be apparent in the African continent, not least, because the continent is presently characterized by high debt levels and at the same, is confronted with infrastructural needs such as those related to the telecommunication and electricity sectors. The theoretical underpinnings are also consistent on the position that good governance is a policy tool with which the negative incidence of debts on economic development externalities can be mitigated (Manasseh *et al.*, 2022; Asongu & le Roux, 2023). It follows that, countries enjoying relative better governance standards are also likely to be associated with a less negative incidence of debt service on economic development externalities, such as the infrastructural outcomes that are considered within the remit of the present exposition.

In the light of the above, from a fundamental perspective, governance has a considerable influence in how societies are organized as well as how institutions manage public affairs, especially as it pertains to investments and resource endowments. It follows that governance can play a role of overseeing how external borrowing is managed, especially in relation to whether the investments for which the funds are borrowed are used for the purposes for which the corresponding funds were borrow. Moreover, intuitively, governance can also oversee how the underlying external debt is serviced so that *inter alia*, concerns related to debt service do not potentially affect the capacity of the country to borrow in the future and/or crowd-out the

capacity of the country to invest in economic development infrastructure such as information and communication technology as well as electricity access infrastructure.

The governance variables employed in the present study are broadly consistent with Kaufmann *et al.* (2007), Khan (2007), non-contemporary literature (North, 1990) as well as contemporary governance-centric studies (André *et al.*, 2015; Asongu *et al.*, 2021). Consistent with the attendant literature, three main types of governance dynamics are considered within the remit of the present exposition, namely: (i) political governance or the election and replacement of political leaders. This indicator is proxied by political stability/no violence and 'voice & accountability'. (ii) Economic governance which is understood as the formulation and implementation of policies that delivers public goods and services. This notion of economic governance is proxied by regulatory quality and government effectiveness. (iii) Institutional governance is understood as the respect by the State and citizens of institutions that govern interaction between them. It is proxied by corruption-control and the rule of law. These underlying definitions are consistent with contemporary governance literature (Asongu & Odhiambo, 2021).

In the light of the above, the following testable hypotheses will be considered in the empirical results section of this study.

Hypothesis 1: Short term debt service reduces infrastructure development in terms of access to electricity and information technology.

Hypothesis 2: Governance dampens the unfavorable incidence of short term debt service on infrastructural development within the remit of access to electricity and information technology.

Figure 1: debt service, information technology and access to electricity

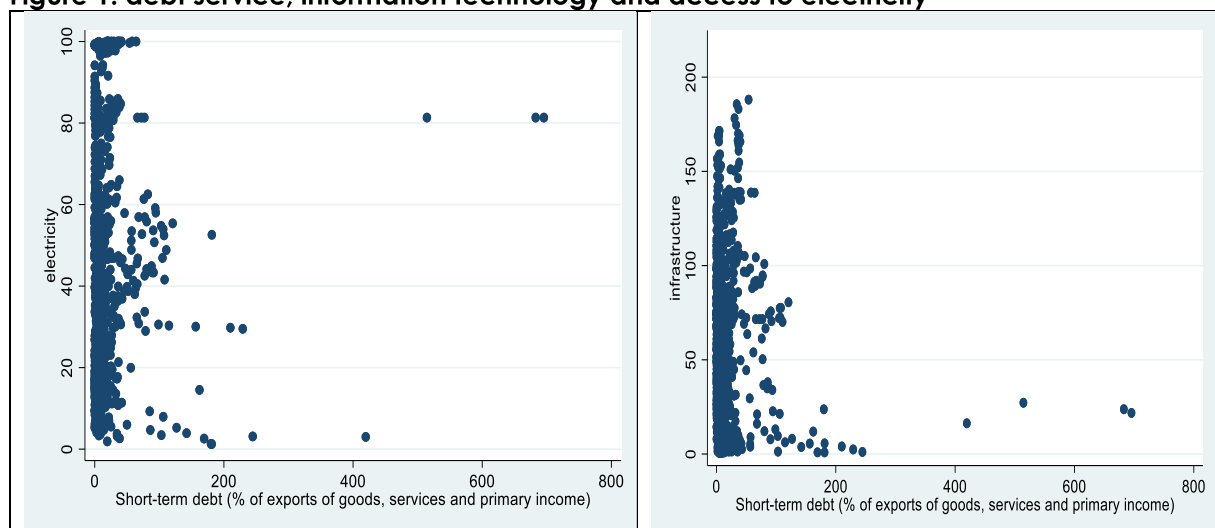


Figure 1 above shows nexuses among short-term debt service, technology infrastructure and access to electricity. While the left-hand side shows the association between access to electricity and short-term debt service, the right-hand side illustrates the linkage between technology infrastructure and short-term service. From both sides of the figure, consistent with Hypothesis 1, it is apparent that high access to electricity and technology infrastructure are associated with low short-term debt services. Moreover, how governance moderates the corresponding nexuses is a matter of empirical validity which is the purpose of the empirical analysis in the sections that follow.

3. Data and methodology

3.1 Data

Consistent with Asongu and le Roux (2023), the present study focuses on 52 African countries with data for the period 2002 to 2021. The focus on the countries as well as corresponding periodicity are motivated by constraints in the availability of data at the time of the study, notably: (i) governance variables without missing data are only apparent after the year 2000 and (ii) two countries (Djibouti and South Sudan) are left out owing to data availability constraints. The data are obtained from two principal sources, namely: (i) World Development Indicators (WDI) for the World Bank from which the outcome, debt service and control variables (population and gross fixed capital formation) are sourced and (ii) World Governance Indicators (WGI) of the World Bank from which, the six governance indicators are sourced, namely: political stability/no violence, 'voice & accountability', regulatory quality, government effectiveness, corruption-control and the rule of law.

Consistent with the narrative on the motivation in the introduction, especially in the light departing from Manasseh *et al.* (2022), the outcome variable which is infrastructure is proxied by telephone penetration and electricity access. The choice of these indicators to proxy for infrastructure is in line with the extant economic development and infrastructure literature (Nchofoung & Asongu, 2022; Nchofoung *et al.*, 2022). Consistent with the motivation of the study, instead of total debt, external debt service is used as the main independent variable of interest, thus departing from Manasseh *et al.* (2022). Moreover, the choice of the six governance variables is also consistent with the extant literature on the nexus between external debt dynamics and macroeconomic outcomes (Manasseh *et al.*, 2022; Asongu & le Roux, 2023). The adopted two control variables which are also in line with Manasseh *et al.* (2022) are expected to positively influence the adopted macroeconomic outcome variables, notably because, *inter alia*: (i) increasing population motivates the need for more infrastructure especially as it pertains to telephone penetration and demand for electricity access and (ii) the promotion of the underlying infrastructure dynamics requires capital.

Consistent with Manasseh *et al.* (2022), economic growth is the main outcome variable. The two control variables which have been documented to drive economic growth are also consistent with the underlying study, notably: (i) capital proxied by gross fixed capital formation (GFCF) and labour proxied by the logarithm of the population. The governance dynamics employed as moderating variables are also in line with Manasseh *et al.* (2022) with an exception that the underlying study does not include the rule of law. It follows that the present study adds the rule of law to the engaged five governance dynamics, namely: political stability, 'voice & accountability', government effectiveness, regulatory quality and corruption-control. Another worthwhile distinguishing characteristic is that the present exposition employs

short term debt service as the main mechanism as opposed to total external debt used by Manasseh *et al.* (2022).

The definitions of the variables as well as corresponding sources are disclosed in Appendix 1 whereas the corresponding summary statistics is provided in Appendix 2. Disclosure of elements in the appendix is completed with insights into the correlation matrix which is provided in Appendix 3. Information from the summary statistics enables the computation of the net effects of external debt service on the outcome variable, thus avoiding the estimated coefficients from the interactive regressions from being understood and interpreted as in linear additive models, following the caution of Brambor *et al.* (2006).

3.2 Methodology

3.2.1 Specification

Consistent with the motivational elements documented in the introduction, especially as it pertains to the positioning with respect to Manasseh *et al.* (2022), the present study adopts the generalized method of moments (GMM) empirical strategy as estimation technique. Furthermore, the choice of the GMM estimation approach is both motivated by consistency of the underlying technique with the data structure as well as elements of robustness of the techniques which are discussed in what follows. First, the number of countries is higher compared to the number of years in each period because the study is focused on 52 countries with data for the period 2002 to 2021 which entails 20 years. Second, persistence in the outcome variable is apparent, especially given that the correlation between the first lag and level series of the outcome variables are respectively higher than 0.800 which is the rule of thumb established in the GMM-centric literature for the adoption of the attendant estimation approach (Tchamyu, 2019; Efobi *et al.*, 2019). Third, the estimation exercise is tailored to account for cross-country differences. Fourth, some aspects of endogeneity are accounted for in the estimation technique, notably: (i) time or year effects are employed to control for cross sectional dependence and the unobserved heterogeneity and (ii) an instrumentation process is employed to account for the simultaneity or reverse causality dimension of endogeneity.

The following equations in levels (1) and first difference (2) summarize the estimation procedure for the relevance of governance dynamics in external debt service to influence infrastructure development.

$$Infr_{i,t} = \sigma_0 + \sigma_1 Infr_{i,t-\tau} + \sigma_2 Debt_{i,t} + \sigma_3 Gov_{i,t} + \sigma_4 Inter_{i,t} + \sum_{h=1}^2 \delta_h W_{h,i,t-\tau} + \eta_i + \xi_t + \varepsilon_{i,t} \quad (1)$$

$$Infr_{i,t} - Infr_{i,t-\tau} = \sigma_1 (Infr_{i,t-\tau} - Infr_{i,t-2\tau}) + \sigma_2 (Debt_{i,t} - Debt_{i,t-\tau}) + \sigma_3 (Gov_{i,t} - Gov_{i,t-\tau}) + \sigma_4 (Inter_{i,t} - Inter_{i,t-\tau}) + \sum_{h=1}^2 \delta_h (W_{h,i,t-\tau} - W_{h,i,t-2\tau}) + (\xi_t - \xi_{t-\tau}) + (\varepsilon_{i,t} + \varepsilon_{i,t-\tau})' \quad (2)$$

where $Inf_{i,t}$ show infrastructure (i.e. telephone penetration and electricity access) of country i in period t ; $Debt$ represents short term debt service; Gov is a governance dynamic (i.e. political stability/no violence, 'voice & accountability', government effectiveness, regulatory quality, corruption-control and the rule of law); $Inter$ reflects the interaction between external debt service and a governance dynamic; σ_0 is a constant; τ is the degree of auto-regression which is considered as one in this research because a one period lag is enough to capture previous information; W entails the vector of control variables (Gross fixed capital formation and population), η_i is the country-specific effect, ξ_t is the time-specific constant and $\varepsilon_{i,t}$ the error term. In the present research, the GMM analytical technique is based on forward orthogonal deviations, in the light of Roodman (2009). It is thus, an improved version of the Arellano and Bover (1995) technique which has been established to provide results with more robust estimated coefficients compared to more traditional difference and system GMM approaches (Boateng et al., 2018; Tchamyoyou et al., 2019).

It is important to note that other techniques such the Vector autoregressive (VAR) or Vector Error Correction Model (VECM) approaches are not employed because the periodicity is too small. This is essentially because the corresponding models require that the observations should be at least 30. Accordingly, the study is for the period 2002 to 2021. Moreover, contrary to VAR or VECM models, GMM models are usually constructed for estimators with a short time horizon. Hence, unit-root and cointegration tests which are consistent with long run horizons are not indispensable. Accordingly, in practice, what is relevant according to Kripfganz (2019) is less of the concern that unit root might be apparent but more generally, the concern of identification which is addressed in the post-estimation diagnostics tests used to assess the validity of the estimated models. Furthermore, most panel unit tests require balanced panel data structure which is not the case in this study.

3.2.2 Identification, simultaneity and exclusion restrictions

In a robust GMM approach, insights are relevant into elements pertaining to identification, simultaneity and exclusion restrictions that are particularly relevant in a robust specification. The underlying elements are expanded in turn, in the following narratives. First, the framework of identification embodies clarification of three main concepts underlying the specification framework, namely: the outcome variable, the endogenous explaining or predetermined variable and the strictly exogenous variable. According to the motivation of the study as well as disclosed elements in the data section, the outcome variables in this study are proxies for infrastructure development such as telephone penetration and electricity access. In line with the extant GMM-centric literature, the predetermined or endogenous explaining variables are

all independent variables of interest (i.e., governance dynamics and short-term debt service) as well as the considered control variables (i.e. population and gross fixed capital formation) (Tchamyou & Asongu, 2017; Meniago & Asongu, 2018). With respect to the strictly exogenous variables, years are considered as strictly exogenous in the study because accordingly to Roodman (2009), years are unlikely to be endogenous after a first difference.

Second, looking at the simultaneity dimension of this section, it is relevant to emphasize that the concern surrounding reverse causality is addressed by means of instrumental variables using forward differences. This is done by means of Helmert transformations in order to purge fixed effects that can potentially bias estimated coefficients due to the correlation between fixed effects and the lagged dependent variable. Such a process for elimination fixed effects is in accordance with the attendant literature on the subject; especially given the underlying transformation that enable parallel or orthogonal conditions between forwarded differenced and lagged observations (Arellano & Bover, 1995; Love & Zicchino, 2006; Roodman, 2009).

Third, focusing on the exclusion restriction hypothesis, consistent with elements discussed in the first strand of this section, the Difference in Hansen Test (DHT) is employed to assess the assumption as to whether the identified strictly exogenous variables influence the outcome variables exclusively via the exogenous dimension of the endogenous explaining variables. The information criteria for the validity of instruments is consistent with more traditional GMM-centric approaches in which the Hansen/Sargan tests should not be rejected in order for the identified instruments to elucidate the outcome variables, exclusively through the identified channels (Amavilah *et al.*, 2017).

It is worthwhile to note that the high standard deviation of the debt service which is an independent variable of interest, shows that reasonable estimated linkages can be derived from the findings. Moreover, the high standard deviation of an infrastructure indicator which is the outcome variable shows that an estimation technique that considers infrastructure throughout the conditional distribution of infrastructure can be worthwhile. However, the periodicity is too short for methods such as quantile regressions to be considered. Accordingly, quantile regressions require a huge dataset and long periodicity for implementation. It is also worthwhile to note that country-specific effects which are potential causes of high standard deviations are eliminated in the GMM estimation process.

4. Empirical results

The empirical results are disclosed in this section in Tables 1-2. Table 1 focuses on linkages between governance, short term debt service and electricity access while Table 2 is concerned with nexuses between governance, short term debt service and telephone infrastructure. Each table is divided into seven main columns; the first column shows the variables and corresponding information criteria for the validity of models while the last-six columns reflect findings pertaining to respectively: political stability, 'voice & accountability', government effectiveness, regulatory quality, corruption-control and rule of law; in this order. The acknowledgement of valid models is in line with established information criteria for the validity of GMM models¹. It is also worthwhile to note that the estimated coefficients are not contradictory to the short run debt servicing because the GMM estimates are by definition short term effects. Long term effects can subsequently be computed by dividing the estimated coefficient with the following denominator: "One minus the estimated lagged dependent variable" (Reed & Zhu, 2017).

In order for the investigated hypotheses to be valid, two conditions must be met. The unconditional incidence of debt service on the outcome variable should be negative in order for *Hypothesis 1* to be valid while the overall effect of external debt on the outcome variables should negative in order for *Hypothesis 2* to be valid. The overall effect of external debt service entails both unconditional effect of debt services (i.e., validity of *Hypothesis 1*) as well as the conditional or interactive effect of debt service. Hence, consistent with Asongu and le Roux (2023) and contrary to the results of Manasseh *et al.* (2022) for which interactive estimates are disclosed without the corresponding unconditional incidence, which is obviously a pitfall in interactive regressions documented in Brambor *et al.* (2006), the present exposition computes overall or net effects.

In the light of the above, to put the computation of net effect into perspective, in the penultimate column of Table 1, the net effect of short-term debt service on electricity access, contingent on corruption-control is -0.066 $[-0.153 \times -0.604] + [-0.159]$. In the corresponding specification, -0.604 is the mean value of corruption-control, -0.159 is the unconditional effect of short-term debt service on electricity access while -0.014 is the conditional or interactive impact of short-term debt service on electricity access. As clarified in the footnote of the

¹ "First, the null hypothesis of the second-order Arellano and Bond autocorrelation test (AR (2)) in difference for the absence of autocorrelation in the residuals should not be rejected. Second the Sargan and Hansen over-identification restrictions (OIR) tests should not be significant because their null hypotheses are the positions that instruments are valid or not correlated with the error terms. In essence, while the Sargan OIR test is not robust but not weakened by instruments, the Hansen OIR is robust but weakened by instruments. In order to restrict identification or limit the proliferation of instruments, we have ensured that instruments are lower than the number of cross-sections in most specifications. Third, the Difference in Hansen Test (DHT) for exogeneity of instruments is also employed to assess the validity of results from the Hansen OIR test. Fourth, a Fischer test for the joint validity of estimated coefficients is also provided" (Asongu & De Moor, 2017, p.200).

corresponding table, some net effects are not computed either because the model is not valid or because at least one estimated coefficient needed for the corresponding computation is not significant.

Given the above information criteria, *Hypothesis 1* is valid in two specifications of Table 1 (i.e., regulatory quality and corruption-control) and four specifications of Table 2 (i.e. government effectiveness, regulatory quality, corruption-control and rule of law). Moreover, *Hypothesis 2* is also consistently valid because the negative magnitude of the unconditional effect is dampened by the corresponding governance dynamic. It follows that a less negative overall net effect (i.e., relative to the unconditional negative effect) is evidence that the corresponding governance dynamic moderates short term external debt service to reduce the unfavorable effect of short term debt service on electricity access. To put this in greater perspective with the previous example, in the penultimate paragraph of Table 1, the unconditional effect of external debt on access to electricity is -0.159 while the overall net effect from the moderating role of corruption-control in the effect of short-term debt service on access to electricity is -0.066. Hence, since the latter is lower than the former in negative magnitude, *Hypothesis 2* is valid.

Table 1: Governance, short term debt service and access to electricity

Dependent variable: Access to electricity						
Constant	- 70.797*** (0.001)	- 106.36*** (0.000)	- 79.262*** (0.000)	- -132.901*** (0.000)	- 88.115*** (0.003)	- 135.360*** (0.000)
Political Stability (PS)	-0.380 (0.657)	---	---	---	---	---
Voice & Accountability (VA)	---	2.825** (0.043)	---	---	---	---
Gov't Effectiveness (GE)	---	---	3.317 (0.191)	---	---	---
Regulatory Quality (RQ)	---	---	---	1.820 (0.405)	---	---
Corruption-Control (CC)	---	---	---	---	3.169 (0.122)	---
Rule of Law (RL)	---	---	---	---	---	2.707 (0.220)
Short Term Debt Service (STDS)	-0.046 (0.151)	-0.182*** (0.001)	-0.137*** (0.001)	-0.231*** (0.000)	-0.159*** (0.008)	-0.190*** (0.003)
PS × STDS	-0.033* (0.062)	---	---	---	---	---
VA × STDS	---	-0.164*** (0.000)	---	---	---	---
GE × STDS	---	---	-0.130*** (0.000)	---	---	---
RQ × STDS	---	---	---	-0.205***	---	---

				(0.000)		
CC × STDS	---	---	---	---	-0.153*** (0.006)	---
RL × STDS	---	---	---	---	---	-0.161*** (0.000)
Population	9.320*** (0.001)	14.547*** (0.000)	11.114*** (0.000)	17.936*** (0.000)	12.403*** (0.002)	18.381*** (0.000)
GFCF	0.024 (0.593)	0.031 (0.490)	0.012 (0.790)	-0.006 (0.909)	-0.002 (0.960)	0.036 (0.441)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
Net Effects	na	na	na	-0.091	-0.066	na
AR(1)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
AR(2)	(0.692)	(0.727)	(0.653)	(0.584)	(0.592)	(0.611)
Sargan OIR	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Hansen OIR	(0.118)	(0.048)	(0.049)	(0.104)	(0.108)	(0.092)
DHT for instruments						
(a) Instruments in levels	(0.287)	(0.054)	(0.089)	(0.065)	(0.155)	(0.094)
H excluding group	(0.119)	(0.149)	(0.108)	(0.274)	(0.168)	(0.197)
Dif(null, H=exogenous)						
(b) IV (years, eq(diff))	(0.037)	(0.018)	(0.009)	(0.014)	(0.021)	(0.041)
H excluding group	(0.512)	(0.367)	(0.534)	(0.724)	(0.625)	(0.391)
Dif(null, H=exogenous)						
Fisher	539.58***	304.34***	677.40***	346.45***	661.77***	196.53***
Instruments	32	32	32	32	32	32
Countries	41	41	41	41	41	41
Observations	687	687	687	687	687	687

***, **, *: significance levels at 1%, 5% and 10% respectively. DHT: Difference in Hansen Test for Exogeneity of Instruments Subsets. Dif: Difference. OIR: Over-identifying Restrictions Test. The significance of bold values is twofold. 1) The significance of estimated coefficients and the Wald statistics. 2) The failure to reject the null hypotheses of: a) no autocorrelation in the AR(1) & AR(2) tests and; b) the validity of the instruments in the Sargan and Hansen OIR tests. The lagged estimated outcome variable is included in the regression. The mean values of regulation quality and corruption-control and the rule of law are, -0.679 and -0.604, respectively. n.a: not applicable because the model is either not valid or at least one estimated coefficient needed for computation of net effect is not significant.

Table 2: Governance, short term debt services and information technology

	Dependent variable: Information technology					
Constant	68.996** (0.012)	54.860 (0.147)	137.536*** (0.000)	128.196*** (0.001)	83.875*** (0.003)	85.369** (0.022)
Political Stability (PS)	2.194 (0.127)	---	---	---	---	---
Voice & Accountability (VA)	---	1.416 (0.512)	---	---	---	---
Gov't Effectiveness (GE)	---	---	10.867***	---	---	---

			(0.007)			
Regulatory Quality (RQ)	---	---	---	12.985***	---	---
				(0.001)		
Corruption-Control (CC)	---	---	---	---	7.410**	---
					(0.026)	
Rule of Law (RL)	---	---	---	---	---	8.118**
						(0.011)
Short Term Debt Service (STDS)	-0.117	-0.080	-0.253***	-0.153*	-0.320***	-0.137*
	(0.160)	(0.289)	(0.000)	(0.080)	(0.001)	(0.068)
PS × STDS	-0.055	---	---	---	---	---
	(0.242)					
VA × STDS	---	-0.050	---	---	---	---
		(0.274)				
GE × STDS	---	---	-0.211***	---	---	---
			(0.001)			
RQ × STDS	---	---	---	-0.155**	---	---
				(0.028)		
CC × STDS	---	---	---	---	-0.254***	---
					(0.000)	
RL × STDS	---	---	---	---	---	-0.108**
						(0.019)
Population	-7.870**	-5.997	-14.849***	-13.769***	-8.662**	-8.929*
	(0.016)	(0.207)	(0.001)	(0.004)	(0.017)	(0.056)
GFCF	0.145*	0.114	0.012	0.082	0.082	0.124
	(0.083)	(0.146)	(0.897)	(0.394)	(0.399)	(0.112)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
Net Effects	na	na	-0.102	-0.047	-0.166	-0.065
AR(1)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
AR(2)	(0.516)	(0.585)	(0.812)	(0.709)	(0.730)	(0.759)
Sargan OIR	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Hansen OIR	(0.137)	(0.242)	(0.217)	(0.116)	(0.144)	(0.141)
DHT for instruments						
(a) Instruments in levels						
H excluding group	(0.030)	(0.042)	(0.040)	(0.019)	(0.056)	(0.021)
Dif(null, H=exogenous)	(0.508)	(0.669)	(0.629)	(0.538)	(0.397)	(0.591)
(b) IV (years, eq(diff))						
H excluding group	(0.119)	(0.034)	(0.051)	(0.174)	(0.168)	(0.301)
Dif(null, H=exogenous)	(0.286)	(0.856)	(0.703)	(0.175)	(0.233)	(0.135)
Fisher	2528.03***	1470.87***	722.32***	1105.51***	1003.48***	593.39***
Instruments	32	32	32	32	32	32
Countries	41	41	41	41	41	41
Observations	687	687	687	687	687	687

***, **, *: significance levels at 1%, 5% and 10% respectively. DHT: Difference in Hansen Test for Exogeneity of Instruments Subsets. Dif: Difference. OIR: Over-identifying Restrictions Test. The significance of bold values is twofold. 1) The significance of estimated coefficients and the Wald statistics. 2) The failure to reject the null hypotheses of: a) no autocorrelation in the AR(1) & AR(2) tests and; b) the validity of the instruments in the Sargan and Hansen OIR tests. The lagged estimated outcome variable is included in the regression. The mean values of government effectiveness, regulation quality, corruption-control and the rule of law are, -0.712,

-0.679, -0.604 and -0.658, respectively. n.a: not applicable because the model is either not valid or at least one estimated coefficient needed for computation of net effect is not significant.

The control variables have the expected signs for the most part. Accordingly, the positive incidence of gross fixed capital formation on the outcome variables is consistent with both intuition and the extant literature, not least, because improvements in capital savings that are available for investment purposes should obviously be positively linked to the outcome variables considered in the present exposition (Solow, 1956; Manasseh *et al.*, 2022). Moreover, while population growth increases the demand for access to electricity, the nexus with telecommunication infrastructure can have a opposite sign contingent on whether there is a still a great deal of room for electricity access demand compared to telecommunications infrastructure. From a comparative standpoint, thus it is apparent that people in Africa have mobile phones even when they lack electricity access to charge the phones (The Economist, 2013).

Concerning the nexus with the extant literature, it is worthwhile to emphasize that the established findings are not consistent with the extant neoclassical growth theory and overhang theory literature documenting the positive nexus between external debts and economic development outcomes. Our findings are thus consistent with a stream of the extant literature on the negative implications of external debt on economic development externalities (Elibadawi *et al.*, 1997; Fosu, 1999; Pattillo *et al.*, 2002; Were, 2001; Jayaraman & Lau, 2008; Adegbite *et al.*, 2008; Rodrik, 1999; Onyekwelu & Ugwuanyi, 2014; Agbemavor, 2015; Asongu & le Roux, 2023).

The positive relevance of governance in favorably moderating the incidence of external debt service on electricity access and infrastructure development is consistent with the extant literature on the importance of governance in overseeing the management of external debt, especially as it pertains to the use of the external debt for investment purposes as well as effective debt service management (North, 1990; Khan, 2017; Manasseh *et al.*, 2017; World Bank, 2018).

5. Concluding implications and future research directions

The study has investigated the role of governance (i.e., 'voice & accountability', political stability/no violence, regulatory quality, government effectiveness, corruption-control and the rule of law) in the incidence of short-term debt services on infrastructure development in the perspective of telecommunication infrastructure and access to electricity. The focus of the study is on 52 African countries for the period 2002-2021. The generalized method of moments is employed as estimation strategy and the following findings are established. Debt service has a negative unconditional effect on access to electricity and telecommunication infrastructure. Governance dynamics moderate the negative effect of debt service on infrastructure dynamics. Effective moderation is from regulatory quality and corruption-control for access to electricity and from government effectiveness, regulatory quality, corruption-control and rule of law for telecommunication infrastructure. There are three main policy implications that emerge from the underlying findings.

First, in the light of the results that short term debt service dampens infrastructure development externalities such as telecommunication infrastructure and electricity access, policy makers should put more emphasis on reducing the debt burden in order to mitigate the corresponding negative ramifications of external debts service on the government's ability to provide infrastructural commodities in the country.

Second, it is also important to improve governance standards in order to provide avenues for effect debt management. Measures for such improvement should be tailored towards, *inter alia*, proper conduct in compliance with extant regulations, law, standards as well as social norms within the remit of increasing debt burden and rising debt service in Africa. In this direction, government, policies should be formulated and implemented towards effectively implementing policies surrounding regulations and rules that are adequate in view of allocating external borrowing more efficiently.

Third, the type of governance also matters in the underlying policy recommendations, not least, because we have found from the findings that economic (regulatory quality and government effectiveness) and institutional (corruption-control and the rule of law) governance dynamics are more instrumental in moderating short term external debt service compared to political governance (i.e. entailing political stability and 'voice & accountability'). Accordingly, the study suggests that though debt service cannot be defaulted, good governance can mitigate the unfavorable incidence of debt service on infrastructure development. Moreover, the type of governance also matters in how debt service is moderated to eventually influence economic development outcomes.

The above results are contrary to the findings of Asongu and le Roux (2023) within the remit of economic growth which have shown that only political governance (political stability and 'voice & accountability') and corruption-control are more instrumental in moderating the unfavorable incidence of short-term external debt service on economic growth. A reason for this divergence in findings could be that the institutional and economic dimensions of governance are more linked to the implementation of policies that deliver public commodities such as electricity and telecommunication infrastructure, compared to political governance which is intuitively less linked to the delivery of public goods and services, but more related to the overall economic wellbeing or economic growth in the country. In other words, how debt service negatively affects economic growth can be better addressed by a political governance decision compared to how debt service affects the delivery of public commodities, which depends more on institutional and economic governance decisions.

The findings in this research evidently leave room for future research, especially in the light of engaging other policy instruments that are relevant in managing the unfavorable incidence of external debt on economic development outcomes. Furthermore, given the limitation of the GMM-centric approach that is theoretically and practically tailored to eliminate country-specific effects in order to mitigate concerns related to endogeneity, it is worthwhile for country-specific research to be considered in future studies in order to engender more country-specific policy implications. It also worthwhile the note that, while the choice of the considered infrastructure indicators is motivated by extant contemporary literature, other infrastructure proxies (e.g., urbanization and length of tarmac roads, *inter alia*) should be considered in future research.

Compliance with Ethical Standards

Conflict of Interest: The authors declare that they have no conflict of interest.

Ethical approval: This article does not contain any studies with human participants or animals performed by the authors.

Data availability: the data for this research are available upon request.

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Appendices

Appendix 1: Definition and sources of variables

Variables	Signs	Definitions	Sources
Electricity	Elect.	% of population with access to electricity	WDI
Infrastructure	Infrast	Number of telephone lines plus mobile lines per 100 people	WDI
Political Stability	PS	“Political stability/no violence (estimate): measured as the perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional and violent means, including domestic violence and terrorism”.	WGI
Voice & Accountability	VA	“Voice and accountability (estimate): measures the extent to which a country’s citizens are able to participate in selecting their government and to enjoy freedom of expression, freedom of association and a free media”	WGI
Government Effectiveness	GE	“Government effectiveness (estimate): measures the quality of public services, the quality and degree of independence from political pressures of the civil service, the quality of policy formulation and implementation, and the credibility of governments’ commitments to such policies”.	WGI
Regulation Quality	RQ	“Regulation quality (estimate): measured as the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development”.	WGI
Corruption-Control	CC	“Control of corruption (estimate): captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as ‘capture’ of the state by elites and private interests”	WGI
Rule of Law	RL	“Rule of law (estimate): captures perceptions of the extent to which agents have confidence in and abide by the rules of society and in particular the quality of contract enforcement, property rights, the police, the courts, as well as the likelihood of crime and violence”	WGI
Short term debt service	STDS	Short-term debt (% of exports of goods, services and primary income)	WDI

Population	Pop	Log of total population	WDI
Capital	GFCF	Gross fixed capital formation (% of GDP)	WDI

WDI: World Development Indicators. WGI: World Governance Indicators. GDP: Gross Domestic Product.

Appendix 2: Summary statistics

	Mean	SD	Min	Max	Obs
Electricity	46.762	29.643	1.253	100	1039
Infrastructure	60.735	45.240	0.393	218.740	1039
Political Stability	-0.548	0.887	-3.314	1.200	1039
Voice & Accountability	-0.594	0.736	-2.226	0.979	1039
Government Effectiveness	-0.712	0.636	-2.446	1.056	1039
Regulation Quality	-0.679	0.635	-2.645	1.127	1039
Corruption-Control	-0.604	0.618	-1.868	1.230	1039
Rule of Law	-0.658	0.644	-2.606	1.077	1039
Short term debt service	20.206	49.140	0.000	695.498	807
Population	6.917	0.687	4.916	8.325	1039
Capital	22.172	9.008	2.000	81.021	906

SD: Standard deviation. Min: Minimum. Max: Maximum. Obs: Observations. Adj: Adjusted.

Appendix 3: Correlation matrix (uniform sample size : 712)

	Elect.	Infrast.	PS	VA	GE	RQ	CC	RL	STDS	Pop	GFCF
Elect.	1.000										
Infrast.	0.632	1.000									
PS	0.233	0.221	1.000								
VA	0.201	0.282	0.615	1.000							
GE	0.507	0.409	0.602	0.639	1.000						
RQ	0.368	0.359	0.632	0.704	0.898	1.000					
CC	0.393	0.369	0.667	0.672	0.847	0.810	1.000				
RL	0.482	0.405	0.700	0.718	0.906	0.891	0.891	1.000			
STDS	-	-0.080	-	-	-	-	-	-	1.000		
	0.066		0.189	0.169	0.125	0.207	0.170	0.176			
Pop	-	-0.082	-	-	-	-	-	-	0.013	1.000	
	0.017		0.520	0.171	0.052	0.115	0.271	0.210			
GFCF	0.102	0.163	0.058	-	0.120	0.007	0.127	0.124	-	0.086	1.000
				0.004					0.108		

Elect: Electricity. Infrast: Infrastructure: Gross Domestic Product growth. PS: Political Stability. VA: Voice & Accountability. GE: Government Effectiveness. RQ: Regulation Quality. CC: Corruption-Control. RL: Rule of Law. STDS: Short Term Debt Service. TDS: Total Debt Service. Pop: population. GFCF: Gross Fixed Capital Formation.