AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.

Institutional Quality Explains the Difference of Natural Gas Revenues to Contribute in the Economy: Empirical Evidence from Tanzania

Mwoya Byaro[†] and Abel Kinyondo[‡]

Abstract
This paper uses Tanzanian annual time series data for the period 2007-2016 in a Bayesian MCMC (Markov Chain Monte Carlo) to establish and compare the impact of natural gas revenues and institutional quality in the economy. We found that, the interaction effect between natural gas revenues and institutional quality as contributors to the economy was wide. This difference seems to be largely explained by institutional quality. This suggests that strengthening institutional quality structures in the country will reshape natural gas revenues, providing higher national economic growth. The results are robust due to combinations of prior distribution and likelihood function. These findings have important implications for Tanzania, while also suggesting developing countries with natural resources need to ensure they have implemented appropriate policy measures to improve institutional quality.

Keywords: Economic growth, Institutional Quality, Natural Gas Revenue, Bayesian MCMC
JEL Classification Codes: L95, H27, C11

[†]Corresponding Author, Economist, Ministry of Local Government, Tanzania, Email: byaro2014@yahoo.com
[‡] Senior Lecturer, University of Dar- es-Salaam

1. Introduction

To establish and compare the impact of natural gas revenues and institutional quality on Tanzanian economy, we considered two small producing gas fields (SongoSongo and Mnazi Bay plants) both of which had been in production since 2004 to generate electricity (Deloitte, 2016). These two gas plants supply energy to 42 industries and a number of commercial customers (FEE, 2018). The average annual gas revenue generated by the plants was between 2007 and 2017, US $ 91.4 million (Tanzania Petro Data Hub, 2018). A further, natural gas reserves discovered on the southern coast, estimated at 57 trillion cubic feet, is yet to be extracted (Lange and Kinyondo, 2016). This new natural gas reserves is expected to increase national revenues substantially. Similar expectation was voiced in 2014, when the International Monetary Fund (IMF) suggested, Tanzania could collect annual gas revenues between $3 billion and $6 billion by embarking on gas production (IMF, 2014). The average gas revenues for the new fields has been estimated by the African Development Bank (AfDB) at between $1 billion and $2.2 billion in the first 10 years of production, starting in 2021 (AfDB, 2015), which could potentially lead to strong economic growth (Nkolo, 2018).

However, prior to extraction, it is important to understand how institutional quality has affected the two already producing gas plants (Songosongo and Mnazi Bay) providing a base for policy dialogue and learning that can be applied to future gas extraction. It is also true that, the citizen of Tanzania expect the gas revenues to benefit them and to contribute to the country development (Kinyondo and Villanger, 2017). Tanzania may not be considered oil and gas rich country, since it consumes nearly all the natural gas it produces domestically, with over 45% of electricity produced in the country comes from natural gas (Tanzania Invest, 2018). Tanzania does, however, gain significant revenue from its natural gas industry.

The resource curse literature suggests that countries can suffer from being mineral rich or gas/oil rich. This natural resource curse is not destiny (Bannon & Collier, 2003, p.11), although it is common in Africa where it reflects failures in leadership and governance, weak institutions, weak rule of law, corruption, lack of transparency and accountability. With this in mind, our study has been designed to provide a benchmark for diagnosing any natural gas resource curse in Tanzania, taking into consideration economic growth, natural gas revenues and a governance indicator (institutional quality).

We are aware that, Tanzania is not in a position to export its natural gas resources in return for large amounts of government revenue and also that encouraging domestic utilization of natural gas may not be worthwhile in terms of government revenues, but domestic utilization is necessary for increasing participation along the gas value chain and for stimulating other sectors of the economy. Further, although the discovery of offshore gas is projected to be a more significant in the country's energy sources and rapid economic growth, investment in the sector may become uncertain due to the US $8 fall in liquefied natural gas (LNG) prices in East Asia and the US $11 fall in the average real price over the past 15 years (ESI Africa, 2018).

Such local factors are, as various studies have shown, likely to affect how the revenue accruable from natural resources is used (Sachs et al., 1997; Mehlum *et al.*, 2006, Ross, 2015). It is instructive to look at oil rich countries such as Ghana, Nigeria and Angola which due to poor institutions and corruption have low economic growth, and also at countries with few natural resources such as Korea, Singapore, Taiwan and Hong-Kong where institutions are stronger and economic growth is higher (Sachs & Warner, 1995). Likewise, Norway, a poor country in 1900, is now one of the richest, its growth led by natural resources such as timber, fish, hydroelectric power and more

recently oil and natural gas (Larsen, 2006). More locally Botswana, with 40% of its GDP derived from diamonds enjoys a high growth rate that has been attributed to its better institutions (Sachs & Warner 1995; Acemoglu et al., 2002).

Natural gas revenues, institutional quality and development have a complex relationship. Firstly, in the Tanzania economy, the role of natural gas resources in facilitating economic development is the subject of considerable debate concerning corruption, the instability of gas revenues and the relative effectiveness of policy frameworks (Moshi, 2013). Secondly, natural gas resources are known to link with the **"**resource curse**"**, rent - seeking behavior and various governance problems (Moshi, 2013). Thirdly, as a recent empirical study has shown, the mechanism for resource curse exists in Tanzania, suggesting that corruption can be anticipated and could hamper economic and social development in Tanzania (Alexander et al., 2018). Finally, this dynamics should be affected by the Tanzanian Natural Gas Policy of 2013, which aims to achieve a competitive natural gas industry that significantly contributes to broad based growth and socio-economic transformation (URT, 2013). While relevant literature and grey material on Tanzania does exist, there have been no rigorous studies considering economic growth over time, and how it is affected by natural gas revenues and institutional quality.

This study helps to fill this gap. It uses a Bayesian Markov Chain Monte Carlo (MCMC) simulation, a method vital here given the small sample size (i.e. 10 years of annual data). Estimates obtained from Bayesian MCMC procedures are, unlikely frequentist approaches requiring large samples to approximate confidence intervals, appropriate for small samples that can be simulated into larger samples (Kruschke et al., 2012; Byaro et al., 2017). This approach should make visible the effects of natural gas revenues and institutional quality on economic growth.

The Bayesian MCMC method was used to estimate the posterior distribution of model parameters within a possible range of values (i.e. 95% credible intervals). This method cannot calculate significance of variables, showing only (un)certainty of parameter distribution for a range of possible values within the credible intervals at a probability of 0.95. In contrast, previous empirical literature on the same theme, for instance (Horvath and Zeynalov, 2014; Mehlum et al., 2006; Kolstad and Wiig, 2009; Ross, 2001; Collier and Hoeffler, 2005; Barro, 1999) among others has relied on frequentist/classic econometric techniques. Our major novel contribution here is the use of Bayesian method, which admits the subjectivity inherent in a prior distribution that consists of beliefs regarding the coefficients and error variance.

Our empirical results showed that, in contributing to the wider economy, the interaction effect between natural gas revenues and institutional quality seems larger compared with a no interaction term. Differences in the ability of natural gas revenues to contribute in the economy were largely explained by the institutional quality.

The remainder of this study is organized as follows. While section 2 reviews the literature, section 3 describe the methodology**.** Section 4 presents and discusses the empirical results. Section 5 concludes.

2. Literature Review

While natural resources have played a crucial role in the economic development of many resource rich countries (See Larsen, 2006), can also be an economic curse (Van der Ploeg, 2011). As Barma et al (2012) argued, resource paradox hinges on the quality of institutional which tends to vary. Further, holding GDP constant, resource dependent countries perform less well in governance indicators, indicating the institutional dimensions of the resource curse. These dimensions, Alonso and Garcimartin (2009) suggested, include the development level, income distribution, tax revenue and education. Natural resource endowments can also impact institutional quality indirectly by affecting income distribution and by decreasing tax revenue.

Although these effects vary significantly between OECD and non-OECD countries, natural resource discoveries are associated with high growth in the long (Smith, 2015). Oil has been shown (using panel cointegration techniques, see, Keikha and Mehrara, 2012) to be one of the most important natural resources, constituting a major source of income for many countries. Depending on the institutions of the country, it can either contribute to long term economic growth or lead eventually to poor economic performance. This has been shown, for example by, Olayungbo and Adediran (2017) who used an autoregressive distributed lag (ARDL) to analyze the effects of oil revenue and institutional quality on economic growth in Nigeria. Nigerian oil revenues promoted economic growth in the short run, and reduced it in the long run. The role of Nigerian institutional quality was shown to explain much of the relationship between oil revenue and economic growth. Still, petroleum resources, like other natural resources in Nigeria, seem to lead to an increase income with positive knock on effects to poverty reduction (Bamiduro, 2012).

Conversely, when Warner (2015) tested whether newly 18 booming economies were overcoming the curse of natural resources; the booming sector was found to boost total GDP only temporarily, while none of 18 economies managed to achieve higher growth during, compared to before, the boom period. Overall, most showed no change in growth rates of non-resource GDP per capita during their boom years. Similarly, counter-intuitive results appear in the meta-analysis by Badeeb et al (2017), in which 40% of the 43 empirical papers reported negative effect, 40% reported no effects and 20% reported a positive effect. When potential publication bias and the method heterogeneity are taken into account, these results indicate that, overall support of resource curse hypothesis is weak. The seeming contradictions in this research suggest that, it is not only the exploitation of natural resources that needs examination, but also the context within which that exploitation occurs. As shown by Ross (2013) oil resource extraction corrodes or hampers institutional development in oil countries. This, Ross argues, means that oil wealth is not always a curse, upending the conventional wisdom that oil-rich countries have tended to grow economically at roughly the same level as their oil poor cousins.

At the same time, resources rich countries with poor institutions are doubly at risks of the resource curse, and likely to get worse. It's clear that, the role of institutional quality on natural resource curse has been great. These effects have been identified, for instance by Horvath and Zeynalov (2014), Mehlum et al. (2006) and Kolstad and Wiig (2009), who argue that the natural resource curse can be avoided in the presence of sufficiently high institutional quality. Democratic institutions must be strong enough to resist corruption, political instability, conflicts and other hinderances to their functioning that exploitation of natural resources can bring (See Ross, 2001; Collier and Hoeffler, 2005; Barro, 1999).

3. Methodology and Data Sources.

Bayesian methodology is particularly natural for prediction, because of the way it takes into account parameter or model uncertainty. The predictive distribution is the sampling distribution where the parameters are integrated with the posterior distribution, and is exactly like forecasting, often a key goal of classical time series analysis (Paul et al., 2018). In time series each observation (e.g., $\boldsymbol{y_t}$) is followed by historical knowledge (for example, $\boldsymbol{y_t}$ is a function of $\boldsymbol{y_{t-1}}$**).** Bayesian Markov Chains assume the information required from $\boldsymbol{y_{t-1}}$ is contained in a finite number of the most recent values $\boldsymbol{y_t}$**(**Quintana and Nason, 2012). The MCMC (Markov Chain Monte Carlo) method is an iterative procedure of generating samples from a distribution in which samples are found sequentially, with each new simulated sample based on the previous sample. To put it simply, all classical time series properties, like cointegration, are embedded in the MCMC method (See, Byaro and Musonda, 2017). The basic idea of an MCMC algorithm is to create a stationary time series. It should be kept in mind that MCMC sampling use a time series inference to sample from the final stationary distribution by reducing temporal autocorrelation through thinning. Therefore, each new sample is found based on the previous sample.

Our model in equation (1) is based on the endogenous growth theory developed by Romer (1986). The theory describes achievement of economic growth from forces that are internal to economic system, such as economic institutions and institutional quality. Our model also uses GDP per capita as the dependent variable, to remove the veil of the booming sector as specified in Warner (2015). We then, adopted the ideas of Ntzoufras (2009), so that the likelihood part of the multiple linear regression models reads as: -

$$y_i \sim \mathrm{N}(\mu_i, \tau), \text{ where } \mu_i = \mathrm{X'}_i\beta,\ i=1\ldots, \mathrm{n} \quad \text{and } \tau = \frac{1}{\sigma 2} \tag{1}$$

Where y_i = dependent variables (Real GDP per capita)
$\mathrm{X'}_i$= vector of explanatory variables (corruption index, gas revenue)
β = Coefficient of unknown parameter
μ_i = mean from the estimated regression coefficient
τ = precision or tau

The prior distribution is specified as:-

$$P(\beta, \tau) = \prod_{j=0}^{k} P\left(\beta_j\right) P(\tau)$$

Where $\beta_j \sim N(\mu_{\beta_j}, {c_j}^2)$ and $\tau \sim gamma\ (a, b)$

Prior information is the information external to the data that we incorporate in the analysis. Since no information is available, we chose a uniform prior and the choice of the prior mean is zero ($\beta_j = 0$). This prior choice shows our beliefs around zero, which corresponds to the assumption of no effect of $\mathrm{X'}_i$ (explanatory variables) on y. In other words, we assumed a non-informative prior for each unknown parameter of the model using normal distribution with the large variance (see, Pandey and Singh, 2015). The prior variance ${c_j}^2$ of the effect β_j is set to a large value (for example 10^3) to represent prior ignorance (see, Roberts et al., 2013). For $tau\ (\tau)$, the prior mean is 1 and variance 100, thus making a= b = 0.01. The resulting posterior density is given by

$$P\ (\beta_{0,}\ \beta_{i,}\ ^{\tau}/_{y}) \propto P\ (y/\beta_{0,}\beta_{i,}\tau)\ P(\beta,\tau) \quad (2)$$

Which is equivalent to, (posterior distribution) $\propto$ (likelihood) × (prior); $\beta_{0,}\beta_{i,}$ represents the set of (corruption perception index, natural gas revenue) and $\beta_{0,}$ represents intercept, *y* represents the real GDP per capita; $P(\beta)$ is the prior distribution of the parameter which is derived from theoretical or other prior knowledge. $P(y/\beta_{0,}\beta_{i,}\tau)$ is the likelihood function which describes the real GDP per capita (y) given (corruption perception index and natural gas revenue) as parameter β_i. $P(\beta_{0,}\beta_{i,}\ ^{\tau}/_{y})$ is the posterior distribution for parameter $\beta_{0,}\ \beta_{i,}$ that is (corruption perception index, natural gas revenues) given the real GDP per capita, (y).

3.1 Variable Description and Data Sources.

The variables used in this study are defined as follows:*Real GDP per capita***:** This is the value of total annual output and measured as the final market value of productive activities divided by the population in Tanzania. It measures the real standard of living and economic wellbeing of Tanzanian. Here, it is a proxy for stage of development. *Natural Gas Resources***:** This is measured in terms of natural gas revenues flows. It is the total amount of income derived from the sales of gas annually in the country (Tanzania Petro Data Hub, 2018). Due to the resource curse hypothesis, we expect either a positive or negative relationship with the real GDP per capita. *Corruption Perception Index* (CPI)**:** This is used to measure institutional quality. The CPI is defined by Transparency International (2007) as the misuse of public power for private benefit. CPI reflects institutional quality and is expected to have a positive or negative effect on economic growth.

The study takes advantage of the secondary data available in Tanzania from 2007 to 2016. We sourced data on natural gas revenue from Tanzania Petro Data Hub (2018). The Hub provides annual gas value as the total value of gas consumed. Real GDP per capita is sourced from World Bank Development Indicators (2018), and institutional quality is sourced from the Transparency International from various years (2007-2016). Real GDP per capita is used as the dependent variable while the independent variables were natural gas revenue and institutional quality.

The data was assigned a normal distribution of mean (μ_i) and precision (τ). Mean (μ_i) was given a normal prior with mean 0 and precision 0.001, and τ was given a gamma (0.0, 0.01). The estimation method relied on Markov Chain Monte Carlo (MCMC) simulation to get posterior distribution. The data was analyzed using WinBUGS.

4. Empirical Results and Discussion

The posterior summaries in Tables 1 and 2 are based on an MCMC sample size of 10,000. The performance of the MCMC sampler was assessed by observing convergences through history plots (stationary distribution). The diagnostic test was based on MCMC post estimation through history plots, autocorrelation plots and kernel density (See Figure 1).When the chains converged to the stationary distribution, autocorrelation decreased with the increase in lags (See Figure **1c**), a rapid mixing of the number of chains (Figure 1a), and the kernel density curve takes bell (normal) shape (See Figure 1b). Table 1 summarizes the posterior probability distribution for an unknown parameter coefficient of economic growth given natural gas revenues and institutional quality (represented by corruption index).

Table 1: Bayesian Posterior Results for Economic Growth

			(95 % Credible Interval)	
Parameter	**Mean**	**SD**	**2.5%**	**97.5%**
β_0(intercept)	22.82	32.62	- 40.33	87.45
β_1(Corruption index)	56.41	36.42	-14.46	128.3
β_2(Gas Revenues)	5.89E-6	1.406E-6	3.271E-6	8.819E-6

Source: (Authors computation, 2020).

As shown in Table 1, the Bayesian posterior distribution result for economic growth (GDP per capita) should have a parameter distribution that captures uncertainty about the parameter value. For instance, there is 95% probability that the mean coefficient of natural gas revenue on economic growth lies within the credible intervals (3.271E-6, 8.819E-6). This means, there is certainty that natural gas revenue contributes to increase of economic growth. From our expectation, the means for natural gas revenues are expected to be positive on economic growth. Further, their effect on economic growth is very small.

The mean for the corruption perception index on economic growth (GDP per capita) is expected to be negative; meaning that corruption index (i.e. indicating institutional quality) reduces economic growth. Further, there is 95% probability that the mean coefficient of institutional quality on economic growth (GDP per capita) will be between (-14.46 and 128.3). Since its magnitude sign lies between negative and positive values, this means, there is uncertainty about the institutional quality parameter effect on economic growth.

In other words, the Bayesian posterior results are interpreted within the 95% credible interval and the association between explanatory variables and dependent variables is observed on the signs of the posterior summaries (mean, 2.5% and 97.5% percentiles) (see Byaro et al., 2018). If the signs of posterior results are all positive or negative, the corresponding association can be concluded (Byaro et al., 2018). The 95% credible interval is the probability that the true parameter value lies within the interval.

From (Table 1), the natural gas revenue shows positive signs of the posterior summaries (Mean, 2.5% and 97.5% percentiles). This implies the natural gas revenues would have a positive link with economic growth (as measured by real GDP per capita). As the natural gas revenue increases, it raises the economic growth in Tanzania. At the same time, the mean coefficient of institutional quality indicated by the corruption perception index shows a positive link to economic growth, although the credible interval is very wide, suggesting a lot of uncertainty with the estimate. Since the credible interval values for institutional quality (shown by corruption index) contain both negative and positive percentile, we can say that there is not enough evidence to conclude that institutional quality has a direct positive link to economic growth in Tanzania.

To test the resource curse hypothesis for the case of Tanzania, we used an interactive term of institutional quality (i.e. corruption perception index) and natural gas revenue on economic growth (See Table 2). With the interactive effect of institutional quality (i.e. indicated by corruption index) and natural gas revenues, we reveal more certainty of a positive link on economic growth, meaning that the natural gas resources revenues in presence of good institutional quality contribute positively to economic growth. The mean for interactive effect and the correspondence credible intervals are positive with a probability of 95%. These provide positive and wide credible intervals of parameter values to contribute on economic growth.

This implies that, institutional quality plays a vital role in the management of natural gas revenues to provide a high economic growth in Tanzania.

Table 2: Bayesian Posterior Results for Economic Growth

			(95 % Credible Interval)	
Parameter	**Mean**	**SD**	**2.5%**	**97.5%**
β_0(intercept)	15.93	32.08	- 47.26	78.63
β_1(Corruption index*Gas revenue)	2.429E-6	3.128E-7	3.06E-6	128.3

Source: (Authors computation, 2020)

With regard to the institutional quality, Tanzania has numerous legal and public institutions and instrument related to the management of the natural gas sector and gas sector policies (Kinyondo and Villanger, 2017). Among the legal instrument are the National Natural Gas Policy of 2013, the Oil and Gas Revenue Management Act of 2015 and the Tanzania Extractive Industries (Transparency and Accountability) Act of 2015 (Bishoge et al., 2018). As mentioned earlier, the prevention of resource curse depends on the quality of institutions, and countries with poor institutions are doubly at risks.

The effect of institutional quality and natural gas revenues on economic growth suggested in Table 1 and 2 has support in the literature. As Gurvich (2016) argues, the quality of institutions determines all socioeconomic development indicators. Strong and democratic institutions are also important for investment and long term sustainable growth (See Mauro, 1995; and Barro, 1997). The quality of institutions has also been linked to competitiveness in foreign trade (Nunn and Trefler, 2013). The definition of quality includes having employees that engage in productive activities rather than to join in rent-seeking (Ebeke et al., 2015). In term of effectiveness, as Góes (2015) found, an increase of quality of institutions by 1% lead to an increase of 1.7% in per capita GDP within six years. This implies that, institutional quality is important for achieving higher socioeconomic development. Institutional quality is also key to economic growth, able to cause differences in development across countries (See (North, 1990; Acemoglu and Robinson, 2010; Góes, 2015; Gurvich, 2016). Further, poor institution quality makes it more difficult for the exploitation of natural resources to create economic growth (Mehlum et al. 2006). Weak institutions divert resources from the productive sector to unproductive sectors and promote rent seeking activities where public power is used for private gain or misuse of public resources (Iqbal and Daly, 2014). Therefore, our findings suggest Tanzania needs to invest in strengthening institutional quality; to ensure transparency and accountability with regard to natural gas resources, to promote long term economic growth.

5. Conclusion

Extraction of Tanzania's newly discovered gas, estimated at 57 trillion cubic feet, is yet to begin. Better understanding the impact of earlier extractions of natural gas resources (i.e. Mnazi Bay and SongoSongo plants) provides a broad picture for policy changes and structural reforms regarding expectations of benefits from this extraction. In this study, we examined the impact of natural gas resources (i.e. measured as natural gas revenues flow) and institutional quality (i.e. measured as corruption index) on economic growth for Tanzania in the period 2007-2016. We found a positive impact on economic growth, with an interactive effect between institutional quality and natural gas revenues. This indicates that, natural gas revenues almost certainly contributed positive and greater when the relevant surrounding institutions were strong and transparent (See also, Vijge et al., 2019). In the months leading up to extraction of new discovered natural gas resources, strengthening

institutional quality is critical to avoiding the natural gas resource curse. While a major implication of our result is that, earlier natural gas resources extraction (i.e. Mnazi Bay and Songosongo plants) fostered economic growth in Tanzania for the examined period of time, institutional quality is a strong enough factor in success that tools to build and maintain institutional framework quality. This should always be part of natural gas resources extraction.

Acknowledgment
Dr. Mwoya Byaro would like to thank Prof. Linda McPhee for her valuable comments on the earlier version of this manuscript. The findings, interpretations and conclusions expressed in this manuscript are entirely those of the authors. The manuscript does not necessarily represent the views of the Government of the United Republic of Tanzania.

References

Acemoglu, D. and Robinson, J. (2010). The role of institutions in Growth and Development. *Leadership and Growth, 135.*

Acemoglu, D., Johson, S., & Robinson, J. (2002). An African Success Story: Botswana.

AfDB.(2015). African Development Bank and Bill Melinda Gates Foundation.Timing and magnitude of new natural resource revenues in Africa. *Accessed 16 April 2018.www.afdb.org*

Alexander,C. W., Fjeldstad, O. H., Mmari, D., Sjursen, I. H., &Tungodden, B. (2018). Understanding the resource curse: A large-scale experiment on corruption in Tanzania. *CMI Working Paper* 5.

Alonso, J.A., and Garcimartin, C. (2009).The determinants of institutional quality. More on the debate.*Journal of International Development*, *25*(2), 206-226.

Badeeb, R.A., Lean, H.H and Clark, J. (2017). The evolution of natural resource curse thesis: A critical literature survey. *Resources Policy, 51, pp. 123-134*.

Bamiduro, J. A. (2012). Nigeria and the petroleum resource curse: What Ghana can learn for improved management of oil and gas revenues. *Global J. of Human Social Science, 12, 1-10.*

Bannon, I., and Collier, P. (2003). Natural resources and conflict: What we can do. *Natural Resources and Violent Conflict: Options and Actions, 1-16.*

Barma, N., Kaiser, K., and Le, T.M. (2012).Rents to riches? *The political economy of natural resource-led development. World Bank.*

Barro, R.J. (1997). Determinants of Economic Growth: A Cross-Country Empirical Study. Cambridge, USA; MIT Press.

Barro, R.J. (1999). Determinants of Democracy. *Journal of Political Economy,* 107(S6), S158-S183.

Bishoge, O. K., Zhang, L., Mushi, W. G., and Suntu, S. L. (2018). The overview of the legal and institutional framework for oil and natural gas sector in Tanzania. A review. *Journal of Applied and Advanced Research*, *3*(1), 8-17.

Byaro, M., and Musonda, P. (2017). Per capita income and public health expenditure: what makes good child health outcomes in Tanzania? a comparison of Frequentist and Bayesian approach (1995-2013). *International Journal of Health*, *5*(1), 74-81.

Byaro, M, Kinyondo, A, Michello, C and Musonda, P. (2018). Determinants of public health expenditure growth in Tanzania: An application of Bayesian Model. *African Journal of Economic Review,* 4(1), 1-13.

CIA World Factbook. (2018). Tanzania. http://theodora.com>wfbcurrent

Collier, P. and Hoeffler, A. (2005). Resource rents, governance, and conflict. *Journal of Conflict Resolution,* 49(4), 625-633.

Ebeke, C., Omgba, L. D., and Laajaj, R. (2015). Oil, governance and the (mis) allocation of talent in developing countries. *Journal of Development Economics*, 114, 126-141.

ESI Africa (2018.) https://www.esi-africa.com/tanzania-use-of-natural-gas-can-boost-economic-growth. Retrieved on 17th Sept, 2018.

Góes, C. (2015). Institutions and growth: A GMM/IV panel VAR approach. *Economics Letters*, 138, 85-91.

Gurvich, E. (2016). Institutional constraints and economic development. *Russian Journal of Economics,* 2(4), 349-374.

Horvath, R., and Zeynalov, A. (2014). The natural resource curse in post-soviet countries: The role of institutions and trade policies (No. 341). IOS Working Papers.

IMF. (2014). Fiscal Implication of Offshore Natural Gas. IMF Country Report No.14/121

Iqbal, N., and Daly, V. (2014). Rent seeking opportunities and economic growth in transitional economies. *Economic Modelling*, 37, 16-22.

Keikha, A., Keikha, A. and Mehrara, M. (2012). Institutional quality, economic growth and fluctuations of oil prices in oil dependent countries: A panel cointegration approach. *Modern Economy*, 3(02), 218-222.

Kinyondo, A., and Villanger, S. (2017). Local content requirements in the petroleum sector in Tanzania: A thorny road from inception to implementation? *The Extractive Industries and Society*, 4(2), 371-384.

Kolstad, I., and Wiig, A. (2009). Is transparency the key to reducing corruption in resource-rich countries? *World Development,* 37(3), 521-532.

Kruschke, J. K., Aguinis, H., and Jo, H. (2012). The Time Has Come:Bayesian Methods for Data Analysis in the Organizational Sciences. *Sage Journals,* 15(4),722 -752.

Lange, S., and Kinyondo, A.(2016). Resource nationalism and local content in Tanzania: Experience from mining and consequences for the petroleum sector. *Extractive Industry Society*, 3(4), 1095-1104.

Larsen, E.R. (2006). Escaping the Resource Curse and Dutch Disease? *American Journal of Economics and Sociology,* 65(3), 605-640.

Mauro, P. (1995). Corruption and Growth.*The Quarterly Journal of Economics, 110(3), 681-712.*

Mehlum, H., Moene, K., and Torvik, R. (2006). Cursed by resource or institutions? *World Economy,* 29(8), 1117-1131.

Moshi, B. (2013). Opportunities and challenges for the extraction of natural gas in Tanzania, *Economic and Social Research Foundation*. ESRF discussion paper No. 48.

Nkolo, J.C. (2018). Developing a socially inclusive and sustainable natural gas sector in Tanzania .*Energy Policy,* 118, 356-371.

North, D.C. (1990). Institutional change and economic performance. Cambridge University Press.

Ntzoufras, L. (2009). Bayesian Modelling Using WinBUGS. John Wiley and Sons, Inc.

Nunn, N., and Trefler, D. (2013). Domestic institutions as a source of comparative advantage. NBER Working Paper, 18851.

Olayungbo, D.O., and Adediran, K.A. (2017). Effects of Oil Revenue and Institutional Quality on Economic growth with an ARDL approach. *Energy and Policy Research*, 4(1), 44-54.

Pandey, A., and Singh, O.M. (2015). Projection of some fertility indicators of India using MCMC Technique in Bayesian Procedure. *Research Journal of Mathematical and Statistical Sciences*, 3(7), 9-14.

Pasali, S. (2013). Where is the cheese? Synthesizing a giant literature on causes and consequences of financial sector development. World Bank Policy Research Working Paper, 6655.

Paul, E., Maity, A. K., and Maiti, R. (2018). Bayesian comparative study on binary time series. *Journal of Statistical Computation and Simulation*, 1-16.

Quintana, P. G., and Nason, J. M. (2012). Bayesian Estimation of DSGE Models. Working Paper No 12-4, Federal Reserve Bank of Philadelphia.

Roberts, S., Osborne, M., Ebden, M., Reece, S., Gibson, N., and Aigrain, S. (2013). Gaussian processes for time series modeling. *Phil. Trans. R. Soc. A*, 371(1984).

Romer, P.M. (1986). Endogenous technological change. *Journal of Political Economy*, 98, s71-s102.

Ross, M. L. (2015). What have we learned about the resource curse?.*Annual Review of Political Science*, 18, 239-259.

Ross, M.L. (2001). Does oil hinder democracy? *World Politics*, 53(3), 325-361.

Sachs, J.D., and Warner, A.M. (1995). Natural Resource Abundance and Economic Growth (No. w5398). National Bureau of Economic Research.

Sachs, J.D., and Warner, A.M. (1997). Fundamental sources of long run growth. *The American Economic Review*, 87(2), 184-188

Smith, B. (2015). The resource curse exorcised: Evidence from a panel of countries. *Journal of Development Economics*, 116, 57-73.

Tanzania Economic Outlook. (2017).Joining the dots.https://www2.deloitte.com

Tanzania Invest. (2018). Tanzania Electricity Profile. www.tanzaniainvest.com/power

Tanzania Petro Data Hub.(2018). http://data.tanpetstate.org.

Transparency International. (2007).Corruption Perceptions Index.https://www.transparency.org

URT. (2013).The National Natural Gas Policy of Tanzania. United Republic of Tanzania.

Van der Ploeg, F. (2011). Natural resources: curse or blessings?.*Journal of Economic Literature*, 49(2), 366-420.

Vijge, M. J., Metcalfe, R., Wallbott, L., and Oberlack, C. (2019). Transforming institutional quality in resource curse contexts: The Extractive Industries Transparency Initiative in Myanmar. *Resources policy*, *61*, 200-209.

Warner, M. A. M. (2015). Natural Resource Booms in the Modern Era. International Monetary Fund.

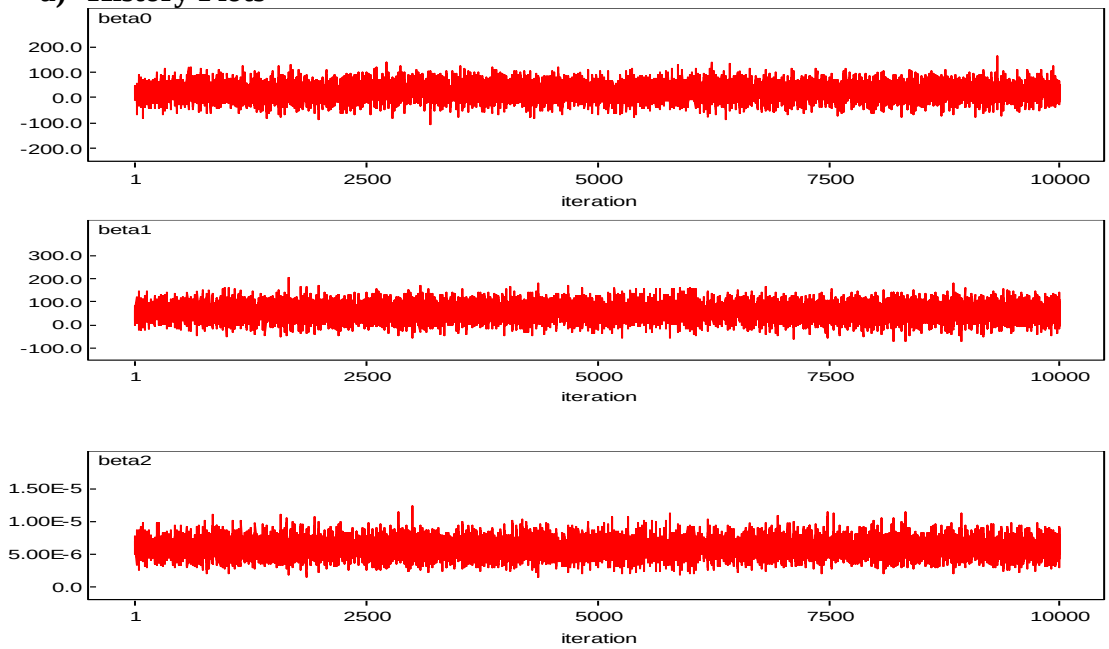
World Bank. (2018).World Bank Development Indicators. http://datacatalog.worldbank.org.

APPENDICES:

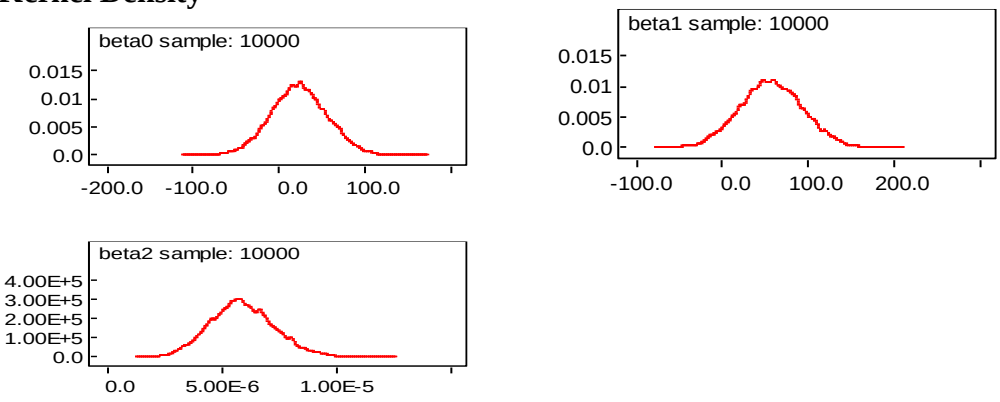
Figure 1(a-c) visualizes the diagnostic tests of the posterior results for economic growth shown in Table 1. The diagnostic tests for Table 2 are not shown here, but we can provide these upon request.

Figure 1: Diagnostic Tests

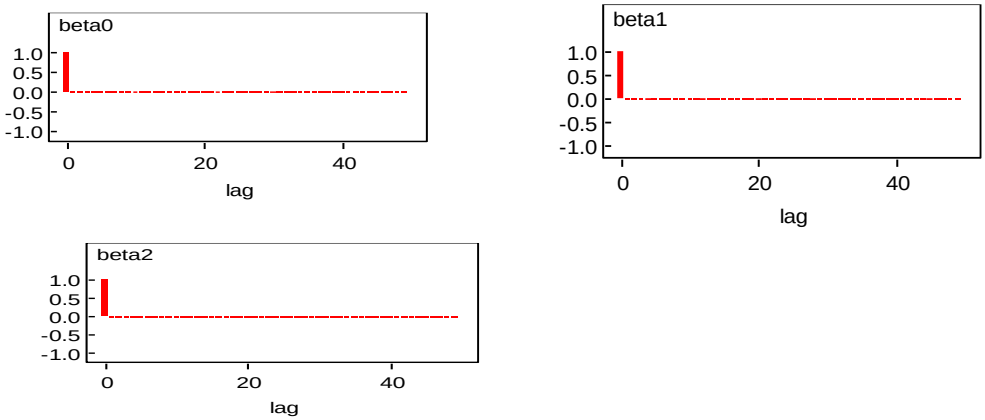
a) History Plots



b) Kernel Density



c) Autocorrelation Plot



Notes: The history plots show the rapid mixing of Markov chains towards convergence to posterior distribution. Kernel density shows normal distribution while no autocorrelation was observed.
Source: (Authors computation, 2020).