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DISAGGREGATE ENERGY PRODUCTION AND THE GROWTH OF MANUFACTURING: A CASE OF KENYA

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Abstract

This study analyzes energy production in Kenya with the aim of assessing its influence on the growth of the manufacturing industry in the country. It recognizes energy as a vital input in manufacturing processes and conceives the growth of manufacturing to be a function of energy production; ceteris paribus . Energy is disaggregated into three main types based on sources of production: hydroelectricity, oil, and renewable sources excluding hydroelectricity. Using time series data (World Bank, 1979-2009), the study focuses on the national production of each type of energy (measured as a proportion of total energy produced) and the percentage annual growth of manufacturing. A multivariate regression analysis based on the least square criterion is then used to estimate the relationship between production of distinct energy types and the percentage annual growth of manufacturing. The findings reveal that collectively, energy production has a strong positive influence on the percentage annual growth of manufacturing. It is further established that renewable energy excluding hydroelectricity makes the greatest contribution to the growth of the manufacturing industry. The study therefore recommends increased efforts in stepping up and coordinating research in renewable energy, and supports the Government's current initiatives to scale up generation of renewable energy.

Keywords: Disaggregate energy, hydroelectricity, oil, renewable, manufacturing value added, energy production, Kenya

INTRODUCTION

The role of energy production in stimulating economic growth remains indisputable. Indeed research reveals a symbiotic relationship between the two. Throughout the world, energy remains a fundamental fuel for economic development. Similarly, economic growth has almost always catalyzed energy production. The Ministry of Energy Kenya (GoK, 2011) singles out energy as one of the enablers for the country's development blueprint: the Vision 2030. For a long time, Kenya has been classified as an energy poor nation (Kidiki, 2008) but the recent discoveries of oil reserves in Turkana County, coal deposits in Kitui County, and gas deposits in Lamu County have raised the country's anticipation in relation to growth in its industries. One such industry expected to register marked improvement with these discoveries is the manufacturing industry. This is because manufacturing is a major consumer of energy.

The manufacturing sector has been earmarked to spur Kenya's socio-economic progress. Not only is it essential for job creation and increased overall GDP, but a vibrant manufacturing sector is also expected to help the country address a substantial number of other national challenges (Scott, 2008; Kimuyu, 2005; Blaus 2008; Onuonga, Etyang & Mwambu, 2011). Like many other nations in the globe, Kenya is grappling with the problem of unemployment among its citizenry in the most productive age brackets- the youth. Indeed, the rising number of unemployed youths, and the growing disillusionment among this cohort of the population, has largely been associated with the rising insecurity presently being experienced in the country.

Compared to other sectors of the economy, the manufacturing sector employs workers at all ages, skills and education levels. It is a substantial employer within the overall formal sector, ranking third among all formal private sector employers. Additionally, manufactured goods are also a significant source of demand for goods and services from other sectors of the economy including services provided by accountants, bankers and software providers (Scott, 2008). This notwithstanding, the Kenya Institute for Public Policy Research and Analysis: KIPPRA, notes that the contribution of the sector to GDP has continued to stagnate at about 10%, with contribution to wage employment on a declining trend (13.9% in 2008 to 12.9% in 2012).

A study of Productivity Performance in Developing Countries (Kimuyu, 2005) reveals that since independence, Kenya's economy has only changed marginally and that while agriculture still dominates, its contribution to the monetary gross domestic product has been on the decline (41% in 1964 to only 25% in 2000). Over this period, contribution of the manufacturing sector increased from a mere 8% to only 14%. At 2011 however, manufacturing only accounted for a mere 10 % of Kenya's GDP. This infinitesimal performance has been linked to a host of challenges. Key among the myriad impediments is the run away cost of manufacturing.

Globally the growth of manufacturing is associated with greater use of inputs. Virtually all manufacturing processes are energy intensive- production, packaging, distribution and transport services. In U.S.A., manufacturers are the largest single consumers of energy. It is applied as both fuel and feedstock (US Manufacturing Council, 2011). In the Kenyan economy, manufacturing is the third largest energy user. It is the second largest user of petroleum products after transport sector, and the largest consumer of electricity (Onuonga et al., 2011; & Institute of Economic Affairs, IEA, 2013). Regardless of type and source, energy prices have escalated over the years and unless manufacturers have invested in energy efficiency, energy costs now present a larger share of operating expenses than ever before (Onuonga et al., 2011; Blaus, 2008; & Kimuyu, 2005). Using the demand supply framework, it is expected that increase in energy production in general will lead to increased annual growth of the manufacturing industry since energy is an important factor of production in manufacturing.

However, as energy consumption and demand grows, the needs for energy security and environmental sustainability have also come to the forefront. Environmental management has thus become a topic of mutual concern for businesses, governments and consumers (Goldstein 2002; & Nyagena, 2007). The emphasis is towards environmentally preferable energy outcomes. This may be achieved by enhanced sustainability, reduction in energy related emissions through increased energy efficiency (which reduces fuel consumption and associated emissions) and/ or by transitioning to less emission-intensive energy sources (U.S. Manufacturing Council; 2011). It is in recognition of the varying impact of the various energy sources on the environment, and on reflection on the question of sustainability of the various energy sources, and the varying degree of investment in and exploitation of the energy type (classified here by source) that this study disaggregates energy into three variables: hydroelectricity, oil and renewable sources excluding hydroelectric. The purpose is to interrogate the impact of each of the three components on the growth and sustainability of the manufacturing industry.

There has been a growing interest in renewable energy due to environmental concerns about global warming and air pollution, reduced cost of renewable energy technologies, and their improved efficiency and reliability. Kindiki (2008) observes that collectively, developing countries have more than half of global renewable power capacity. However, their consumption of this modern energy is the lowest in the world. African energy planners and experts are said to accord low priority to environmental issues in energy development. This is in spite of the fact that the environment is the source of all energy, renewable and non- renewable. By delineating the impact of individual sources of energy, this study points to the contribution of individual energy sources to the GDP. Results may help energy planners and decision makers to re-evaluate investment in various energy sources for sustained economic benefits. It may also pave way for research in the area of sustainable energy development.

It is imperative that the country develops strategies to secure sustainable supply to meet the growing demand. Globally, most energy is produced by the combustion of carbon based fossil fuels (Blaus, 2008). The resulting green house gas emissions are a major cause of global warming and have increasingly become subject to regulations. Consequently, large emitters are more affected by reporting requirements, emission limits and carbon taxes. Their higher operating expenses will be reflected in their higher costs of goods. Blaus (2008) further observes that purchasers also care about the energy consumption and environmental impacts of a product. If a machinery or consumer product is designed to run on carbon based fuel like oil, coal or natural gas, its total cost of ownership will increase with its energy consumption.

In Kenya, petroleum and electricity are the dominant fuel sources in the commercial manufacturing sector (Kimuyu, 2005; KIPPRA, 2010; Ministry of Energy, GoK, 2011 & IEA, 2013).The major sources of electricity include hydroelectricity, thermal oil, geothermal and co-generation; with hydro being the highest contributor of the installed capacity (Kimuyu, 2005 & Ministry of Energy, GoK, 2011). The low level of contribution, according to Kimuyu (2005) and the Ministry of Energy, GoK (2011) is attributable to the deteriorating energy infrastructure and the perennial droughts that plague the country. Informed by this empirical literature, this study hypothesizes that renewable sources of energy excluding hydroelectricity offer manufacturers in Kenya better promise for growth since they are less susceptible to weather fluctuation like hydro, or global energy market changes, like is the case with oil.

The U.S. Environmental Protection Agency (2007) observes that the rising energy costs and the pressure of global competitiveness not only pose continuing challenges for the industrial manufacturing sector but also creates an increasing role in enhancing entrepreneurial competitiveness. Given that energy price shocks are common in the developing world, price increase of energy may lead to substantial increase in the cost of production for manufacturing firms. Kimuyu (2005) observes that power problems are a major impediment to efficiency and productivity. Clearly, a quest for economic growth correspondingly fans the demand for energy. Brandkenya (Brandkenya.co.ke) observes that the manufacturing industry's production slowed down at a rate of 3% in the year 2011 owing to the rise in inflation which in turn lowered the public's demand for products and also due to the high cost of production emanating from energy rationing following low rainfall. Manufacturers had resorted to alternative sources of energy such as thermal power which is quite costly. Interestingly, energy has been singled out as a major cause of inflation as almost every consumed product and service has some energy input (IEA, 2013).

Increase in electricity tariffs poses a great challenge/ risk to Kenya's competitiveness. In the year 2008 for instance, Kenya's electricity tariff was US cents 9.4 per KWh; much higher than South Africa's U.S. cent 6.6 per KWh and Egypt's 3.0 U.S. cents per KWh (KIPPRA, 2010). These two are Kenya's major competitors in trade and service in East and South Africa. India, which is currently experiencing a growth rate of 10%, had very low and competitive tariffs at 5.38 cents per KWh, which is good for industries. It is noteworthy that one of Michael Porter's three generic strategies of competition is low cost production and a country or industry whose cost of production is high will find achieving competitiveness an uphill task.

Table 1: Electricity Tariffs in Kenya in the Year 2009

Sector	**Ksh/ KWh**
Agriculture	12.16
Manufacturing including mining and quarrying	13.03
Electricity and water	11.95
Trade including tourism and insurance	11.80
Transport and communication	13.21
Community and social institution including government	11.76
Households	11.38

Source: National Energy Survey (2009), quoted by KIPPRA (2010)

METHODOLOGY

The research model used in this study is as follows:

$$y_t = ß_o + ß_1 w_t + ß_2 k_t + ß_3 g_t + e_t$$

Where,

y = Manufacturing value added (annual % growth)

w = Hydroelectric energy (% of total energy)

k = Oil energy (% of total energy)

g = Renewable sources, excluding hydroelectric (% of total energy)

e = The stochastic error term.

This study hypothesized that the three predictor variables (w, p and g) together, being important factors of production in manufacturing (Erbaykal, 2008) have a statistically significant positive impact on the growth of manufacturing. It further hypothesized that renewable source of energy excluding hydroelectricity: (g) has the greater benefit due to its greater environmental responsiveness and independence of weather pattern and geo-political factors (US Environmental Protection Agency, 2007; Blaus, 2008; and Kindiki, 2008).

For estimation, the study utilized secondary data from the World Bank publication series (1979-2009). Data was analyzed using Excel and the following output obtained.

RESULTS AND DISCUSSION

Table 2: Regression Statistics

Multiple R	0.602258384
R Square	0.362715162
Adjusted R^2	0.291905735
Standard Error	2.133966437
Observations	31

Table 3. ANOVA Output

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	3	69.97953566	23.32651	5.122413	0.006194
Residual	27	122.9529444	4.553813		
Total	30	192.9324801			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95%*	*Upper 95%*
Intercept	- 1999.235	704.445	-2.838	0.009	-3444.64	-553.833	-3444.64	-553.833
W	20.004	7.040	2.842	0.008	5.560	34.449	5.560	34.449
G	20.256	7.074	2.864	0.008	5.742	34.770	5.742	34.770
K	19.900	7.0321	2.830	0.009	5.472	34.327	5.472	34.327

$$\mathbf{y_t = ß_o + ß_1 w_t + ß_2 k_t + ß_3 g_t + e_t}$$

$$y_t = -1999.235 + 20.0w + 20.3g + 19.9$$

This may be interpreted as:

Percentage (%) annual growth rate of manufacturing = -1999.2 + 20.0% hydroelectric energy + 20.3% renewable energy excluding hydroelectric + 19.9% oil.

Based on the least square criterion, it is evident that there exists a strong positive relationship r = 0.60 between the studied sub-components of energy (hydroelectricity, renewable energy excluding hydroelectricity, and oil) and the growth of manufacturing. However these only accounts for only 29% of variance in annual growth of manufacturing. Clearly, there are other factors involved. As a matter of fact, this study does not factor in all the sources of energy used in manufacturing. A good example of this is biomass energy, which in this case would be classified as non- renewable together with oil (It is often referred to as conditionally renewable since it is not renewable if its exploitation exceeds its regeneration).

Biomass energy is derived from forest formations, farmlands, plantations and agricultural industrial residues and includes wood. The ministry of Energy Kenya (GoK, 2011) notes that industries like cottage industry including tea factories rely heavily on wood for their energy. This concurs with Kindiki's (2008) observation that the increased prices of petroleum fuels and their frequent unavailability often force industries to switch to wood and charcoal. Tobacco industries are also making extensive use of biomass energy. Again, it should also be noted here that energy is only one among other factors of production. In fact, Erbaykal (2008) observes that macroeconomic growth theories in the economy literature focus on labour and capital as the core factors of production and that neo-classical production function explains economic growth with increases in labour, capital and technology and that only recently has energy come to be regarded as an important factor in production.

Hypotheses Testing

Ho: $ß_{1=} ß_{2=} ß_{3=0}$

Ha: One or more of the parameters is not equal to zero

Decision Rule:

At α = 0.05 and d.f = 3, 27 ($F_{0.05}$= 2.96), H_0 is rejected if p-value < 0.05 or $F_{0.05}$ > 2.96.

The calculated alpha 0.0062 < $\alpha_{0.05}$ and 5.12 > $F_{0.05}$ 2.96. H0 is therefore rejected with 95% confidence that production of hydroelectricity, renewable energy excluding hydroelectricity, and oil have a statistically significant influence on the growth of manufacturing. This supports Erbaykal's (2008) findings that both electricity and petroleum consumption have a positive effect on economic growth rate.

This study also aimed at disaggregating the contribution of each energy type to the growth of the manufacturing industry. The results are analyzed here below:

H0: B*i* = 0

Ha: B*i ≠ 0*

w: p-value 0.0084 < $\alpha_{0.05}$ We reject Ho

g : p-value 0.00800 < $\alpha_{0.05}$ We reject Ho

k: p-value 0.0087 < $\alpha_{0.05}$ We reject Ho

The findings support the hypothesis that comparatively, renewable energy excluding hydroelectricity will make greater contribution to the growth of manufacturing industry. Compared to the other two, it involves less cost in the long run although the original set up cost is said to be prohibitively high (IEA, 2013). For instance, it takes approximately seven (7) years from surface exploration to development of a geothermal power plant (Ministry of Energy- GoK, 2011). It however offers far much greater long term benefits. Additionally, Kenya has impressive potential for renewable energy. According to IEA (2013), the country's geothermal potential is estimated at between 7000MWe to 10000MWe spread over 14 prospective sites in the Rift Valley. Solar and wind energy are plentiful throughout the year. Moreover, renewable energy does not incur storage and transportation cost nor importation duties like oil, and neither is it so subject to weather patterns like hydroelectricity (Kimuyu, 2005 & Ministry of Energy- GoK, 2011). Still, the high and often sporadically fluctuating prices of oil make renewable energy more appealing.

CONCLUSION

This study tried to establish the relationship between energy production and growth of manufacturing. It attempted to disaggregate energy into its sub-components with the aim of interrogating the level of contribution of each energy type. It was hoped that such disaggregation would provide guidance to energy planners and decision makers with respect to investment in energy projects. The study established a positive relationship among individual energy sources and the growth of manufacturing industry. The findings also revealed that renewable energy sources excluding hydroelectricity make the greatest contribution to the growth of the manufacturing industry. Considering Kenya's dependency on the Middle East for oil energy, and a sizeable fraction of its hydroelectric energy on Uganda and Tanzania, this study, in line with Kindiki's (2008), advocates for increased effort in stepping up and coordinating research in renewable energy. It supports the current initiatives by the Kenyan Government to scale up generation of renewable energy and recommends that more resources be set aside for the exploration of renewable sources of energy and for installation and refurbishing of renewable-energy projects.

This study was mainly limited by an inadequacy of local empirical studies interrogating energy production and industry performance. Though there is ample literature depicting the country's energy scenario; particularly so, energy demand vis-à-vis energy infrastructure, none to the best of my knowledge has empirically tested the influence of energy infrastructure nor energy generation, on sector performance. Additionally, the operational idiosyncrasies of the informal subsector of the manufacturing industry may have a bearing on the coverage error of the manufacturing industry as a whole. Available literature indicate that many informal sector businesses are hard to identify and locate because they lack fixed and recognizable premises (Hussmann, 2009; Organisation for Economic Cooperation and Development, OECD, 2002) while others are home based. Consequently, the percentage annual grow of manufacturing may not be perfectly represented by the available data. Such discrepancies however are not expected to have significantly influenced the outcome of the study.

REFERENCES

Blaus, G. (2008). Sustainability for manufacturers: Driving profitability and growth. Autodesk Manufacturing White Paper. USA: Autodesk Inc.

Erbaykal, E. (2008). Disaggregate energy consumption and economic growth. Evidence from Turkey. *International Research Journal of Finance and Economics. ISS 1450-2887 Issue 20.*

Fattouh, B. (2007). The drivers of oil prices: The usefulness and limitations of non-structural model, the demand supply framework, and informal approach. Britain: SAOS University of London.

GoK. (2011). Updated Least Cost Development Plan. Nairobi: Energy Regulatory Commission.

Goldstein, D. (2002). Theoretical perspectives on strategic environmental management. *Journal of Evolutionary Economics 12:* pp 495-424. Verlag: Springer

Hussmanns, R. (n.d.): Informal sector surveys. Advantages and limitations of different survey methods and survey designs for data collection. Retrieved April 27, 2015 from http://mospi.nic.in/informal_paper_05.htm

IEA, (2013. July 24th). Energy in Kenya. Proceedings of Energy Scenarios Workshop.

Kammen, M. D. (2006). The Rise of renewable energy. *Scientific American* TM 294, 84 – 93. Doi: 0.1038/scientificamerican0906-84

Kimuyu P (2005): Productivity performance in developing countries: Country case studies; Kenya. Retrieved April 27, 2015 from https://www.unido.org/.../ Productivity _performance _in _ DCs_Kenya.pdf

Kindiki, K. (2008). Synchronizing Kenya's energy law with the framework environmental law. Nairobi: East African Educational publishers.

KIPPRA, (2010). A comprehensive study and analysis on energy consumption patterns in Kenya. Retrieved February 2, 2015 from http://www.kippra.org/

KIPPRA, (2013). Creating an enabling environment for stimulating investment for competitive and sustainable counties. Nairobi: KIPPRA.

Nyagena, W. (2007). The Kenya vision 2030 and the environment: Issues and challenges. EfD Discussion Paper. Retrieved April 5, 2015 from http://www. efdinitiative. org /publications/

OECD. (2002).Measuring the non-observed economy. A handbook. Retrieved April 27, 2015 from https://books.google.co.ke/books?isbn=9264175350

Onuonga, S. M., Etyang, M. & Mwambu, G. (2011). The demand for energy in the Kenyan manufacturing sector. *The Journal of Energy and Development. Volume 34(2)* 265-275.

Scott, E. R. (2008). The importance of manufacturing. Key to recovery in the states and the nation. EPI Briefing Paper No.211. Washington, D.C.: Economic Policy Institute.

The Manufacturing Council (2011): Manufacturing council recommendations. Retrieved April 27, 2015 from www.trade.gov/manufacturingcouncil/recommendations.

U.S. Environmental Protection Agency. (2007). Energy trends in selected manufacturing sectors: Opportunities and challenges for environmentally preferable energy outcomes. VA: ICF International.