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The Effect of Energy Poverty on the Democratic Republic of Congo's Participation in Value Chains

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Abstract

This paper analyses the effect of energy poverty on the Democratic Republic of Congo's participation in value chains over the period 1999-2020. Using the ARDL method. Our main result is that energy poverty worsens the Democratic Republic of Congo's participation in value chains in both the short and long term. Our result remains stable even when we change the measure of participation in value chains. This shows that energy poverty handicaps the Democratic Republic of Congo's participation in upstream and downstream value chains. We conclude with suggestions for improving access to energy, income, and the need to increase industrial enterprises to increase participation in GVCs.

Keywords: Energy poverty, DRC, GVC, ARDL

1. Introduction

Energy poverty has become a major topic of interest for researchers, who have studied its impact on countries' economies in depth. Economically, energy poverty hinders the eradication of economic poverty and economic development (Chakra arty et al., 2013). Socially, energy deprivation affects education and has a negative impact on the average school year of households (Oum, 2019). Households experiencing energy poverty often resort to biofuels (wood, charcoal, dung and waste) to meet their energy needs. However, the combustion process for these fuels is often characterized by low efficiency and poor ventilation, which can have adverse effects on respiratory health (González-Eguino et al., 2015).

Yao et al (2020) have shown that fuel poverty is associated with low levels of economic development. Inequalities in access to energy and specific energy solutions, as well as their societal impact, have major effects on the environment. So-called "energy poor" countries do not have access to safe and clean energy, but rely mainly on low-quality traditional energy sources, which makes their economies less competitive (World Bank, 2018). In contrast, countries with a high level of development have extensive energy infrastructures that provide sufficient energy services for the well-being of their populations. This contrast shows that inequalities in access to energy are linked to economic development and can influence production capacity.

Achieving the development objectives of developing countries therefore requires recognition of the importance of the interaction of energy poverty in the economic and social spheres. This is why the right of access to electricity is enshrined for the first time in the Democratic Republic of

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Congo (DRC), in Article 64 of the Constitution of 18 February 2006, as one of the social and economic rights guaranteed to all. This article reads as follows: "The right to decent housing, the right of access to drinking water and electricity are guaranteed. The law shall determine the manner in which these rights are to be exercised ".However, it has to be said that, despite the constitutional zing of this right and the country's abundant energy resources, the rate of access to electricity in the DRC remains the lowest in Africa (Kusakana, 2016).

The country has an abundance and variety of potential energy resources, the conservation and sustainable management of which are major challenges for the Congolese people and for the rest of the world: biomass, hydroelectric power, solid, liquid and gaseous hydrocarbons (including methane gas from Lake Kivu), mineral coal, oil shale, solar and wind energy potential, uranium ore, and so on. The country's technically exploitable hydroelectric potential is estimated at 774,000 GWh per year, corresponding to exploitable power of around 100,000 MW, distributed unevenly between 217 identified sites, including Inga, which alone represents 44% of the potential, or around 44,000 MW. To date, only 2.6% of this potential has been exploited, i.e. around 2,566 MW, divided between 62 sites in operation, 69% of which, i.e. 1,775 MW, is at the Inga site (351 MW at Inga 1 and 1,424 MW at Inga 2).

Paradoxically, the Congolese population's rate of access to electricity is 9%, compared with an African average of 24.6%, with significant differences between urban areas (access rate = 35%) and rural areas (access rate = 1.0%) (Nkashama, 2015).In other words, only 1.2 million Congolese households have access to electricity, or around 6.5 million out of a population estimated at around 72.8 million. According to Nkashama (2015), these low rates of access to energy have negative effects on the attractiveness of FDI and on production capacity.

The purpose of this paper is twofold: first, it examines the effect of energy poverty on the Democratic Republic of Congo's participation in value chains, thereby providing the information necessary for policy makers to eradicate the problem of energy poverty in order to increase production and economic growth. Secondly, it contributes to the literature in one way or another on participation in value chains. Our empirical strategy is based on the ARDL used to analyze the effect of energy poverty on participation in value chains in the DRC. Thus, our results show that energy poverty weakens the DRC's participation in value chains.

The rest of the paper is structured as follows: Section 2 presents some stylized facts, theoretical foundations and complementary empirical literature. Section 3 shows the methodology used and describes the variables. Preliminary results, basic conclusions and robustness checks are presented and interpreted in Section 4. Section 5 concludes the paper and proposes some policy recommendations.

2. Few stylised facts

From 1995 onwards, there has been a downward trend in energy poverty and GVC. This decline stabilized from 2005, remaining stable until 2010.

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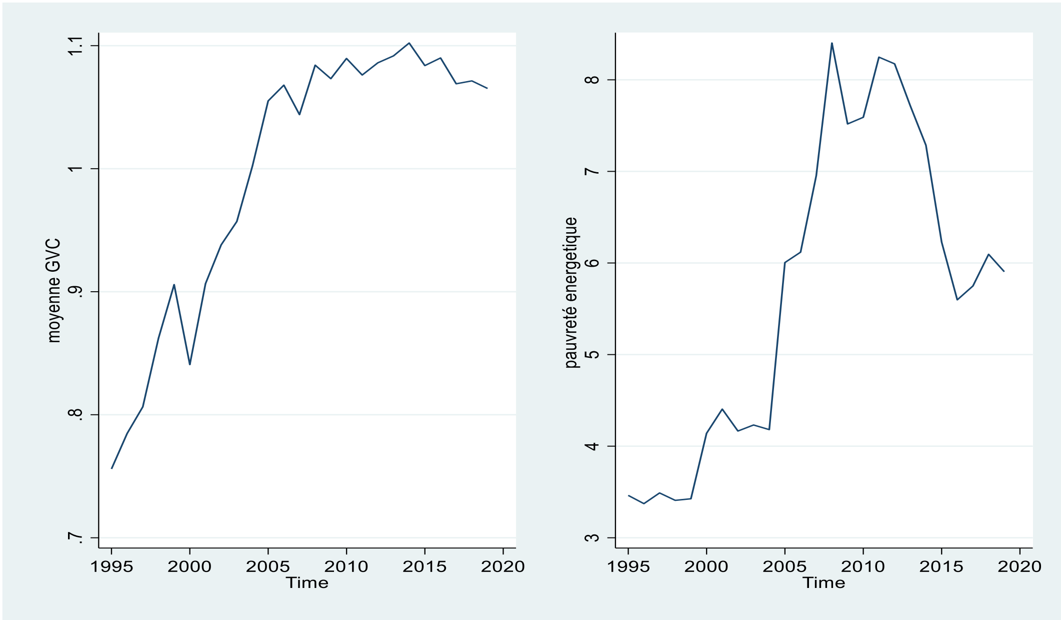
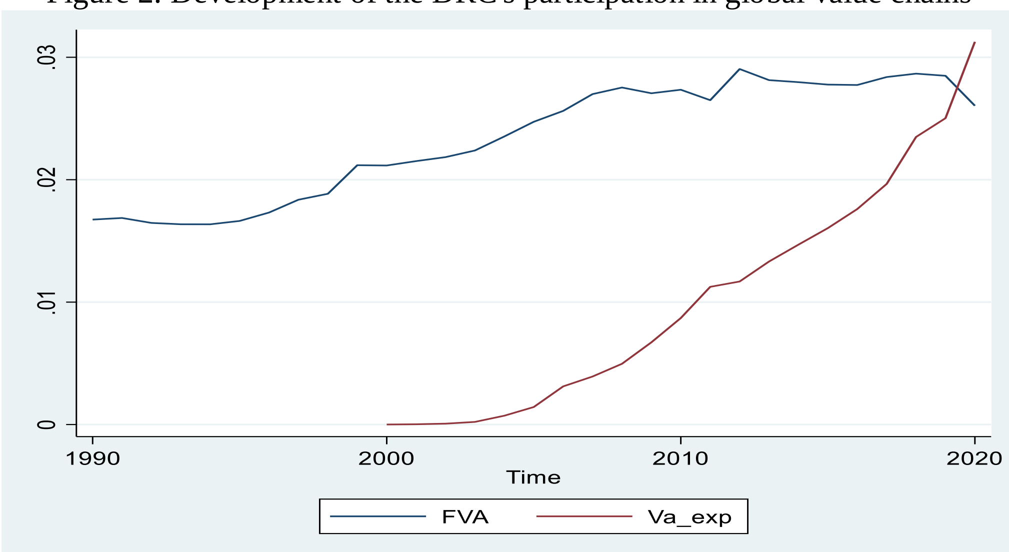
Figure 1. Joint evolution of energy poverty and GVC



Source: author

Figure 2. Development of the DRC's participation in global value chains



Source: author

After observing energy poverty in the DRC, it is important to look at the evolution of the index of participation in global value chains. (GVC). Graph 2 shows that participation in global value chains has increased considerably since the 1990s. This can be seen in two phases. In the first phase (1990 - 2002), participation in global value chains was moderate. The GVC index grew at a relatively slow pace. Compared with the second phase (2002 - 2020), the growth rate of the GVC index is accelerating.

3. Review of the literature

Theoretically, Leach (1987) uses the theory of energy transition to explain the negative effects of fuel poverty. He argues that there is a spectrum of fuel preferences, ranging from low-quality fuels to more convenient and versatile modern fuels. Each type of fuel has distinct effects on the quantity of production. Empirically, studies show that countries with higher electricity consumption have a significant effect on economic growth and human development (Kanagawa et al, 2008). Per capita energy consumption, particularly electricity, is currently one of the most significant indicators of economic development (Chandio et al, 2019). In populous countries such as China and India, energy can provide sustainable and economic benefits for human development, with electricity playing a crucial role in the education and health sectors as well as air pollution control (Rasool et al, 2020). While affordability is the main issue in developed economies, the situation is more complex in developing countries due to the lack of energy resources (Zhang et al, 2019).

Many studies have analyzed the effects of energy poverty on several socio-economic factors. Niu et al (2013) analyzed panel data from 50 countries using the Lorentz curve and the Gini coefficient, dividing these countries into three groups (high, medium and low) and reflecting the economic development of the countries. Pereira et al (2010) reported that rural electrification was a major factor in reducing fuel poverty in Brazil. In the case of the Indian state of Assam, rural electricity has helped to meet poverty reduction targets and has also helped to promote socio-economic development (Kanagawa and Nakata, 2008). Increased urbanization has led to an increase in energy consumption for two main reasons: electricity and the excessive use of household appliances (which the rural population tries to imitate) (Holtedahl and Joutz, 2004).

Increased electricity consumption and higher literacy rates are signs of higher incomes and economic development (Burney, 1995). Energy scarcity resources affect developed and developing countries differently; in developed countries we talk about fuel while in developing countries we talk about energy poverty (Ozturk, 2017). Mixed results regarding the links between fuel poverty and economic development are thus revealed by the literature reviewed. The reason for these mixed results is the application of different empirical models in different countries and different sample sizes. This study, therefore, aims to fill the gap in the existing literature by using different methods and indicators of economic complexity rather than labor and capital.

Numerous studies confirm the positive relationship between energy consumption and economic growth. In countries with insufficient access to energy, basic macroeconomic underperformance underlines the importance of energy consumption in the process of economic development. Although this may seem to be an issue for developing countries, it is possible to speak of regions or groups of people that can be considered energy poor in almost any country therefore energy is essential not only to support a decent quality of life, but also for sustainable growth and productivity. Saghir (2005) has examined in detail the negative effects of lack of access to energy in developing countries on health, gender inequality, education, poverty and overall economic development.

Furthermore, the economic growth observed in recent years has revealed the importance of developing countries' participation in global value chains (GVCs). Participation in these chains is not evenly distributed across all stages of production, and a position in higher value-added activities generates greater economic benefits (OECD-WTO, 2014). After their integration, improving the position of countries in value chains emerges as the best long-term strategy for preserving and increasing the benefits of their participation in MVCs (Cattaneo et al, 2013). The main singularity of the MVC paradigm lies in the variety of its theoretical origins (Inomata, 2017).

According to Temple et al (2011), this approach lies at the intersection of economics, sociology, management science and political science, with a strong historical grounding in development sociology, questioning North-South relations. Moreover, the literature on MVCs has made it possible to understand how relationships in a value chain are coordinated between companies and countries (UNIDO, 2015). The same applies to the rules of the game and the decisions made by firms that affect the distribution of value added. Many authors have also discussed the issues of barriers to entry and the distribution of income within MVCs. Gereffi et al (2011) define a value chain as the set of activities carried out by firms to bring a product or service from its conception to its final use.

The literature shows that few studies have analyzed the influence of energy poverty on participation in value chains.

4. Methodology

The ARDL model is one type of regression model that has been used for decades, but more recently it has proved to be a very useful tool for testing short- and long-term dynamics between economic time series. It is a dynamic model whose explanatory variables are tX(i,t)and its past or lagged values. The term "lagged lags" shows that the short-run effects of X ontY(i,t) differ from the long-run effects. This model was initiated by Pesaran and Smith (1995) and Pesaran et al. (1999). The choice of this model is justified by the fact that it takes into account the heterogeneity bias and assumes that the order of integration of the series cannot exceed 1. The advantages of the ARDL model lie in the fact that it takes into account integrated variables of different order but not exceeding 1. Three estimation techniques are used in this model: Pooled Mean Group (PMG), Mean Group (MG) and Dynamic Fixed Effect (DFE) (Pesaran and Smith 1995; Pesaran et al., 1999).

The difference between these three estimation techniques is that the PMG takes into account the heterogeneity of individuals in the short term and their homogeneity in the long term. The DFE takes into account the total homogeneity of the panel and the MG considers the short- and long-term heterogeneity of individuals. The panel homogeneity tests showed the existence of the inter-invidual dependency relationship. As a result, we have a heterogeneous panel which requires the use of estimators that take into account the heterogeneity of individuals, namely the

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PMG and the MG. In addition, the Hausman test will be used to verify the best estimator between the PMG and the MG. In general, their form is as follows:

$Y_{it}=f(X_{it}, Y_{(it-p)}, X_{(it-q)})$ (1)

According to Pesaran et al (1999), the specification of our ARDL model is as follows:

$Y_{it}=\propto_{it}+\sum_{(\tau=1)}^{p}\beta_o \Delta Y_{(i(t-\tau))}+\sum_{(\tau=0)}^{q}\beta_1 \Delta X_{(i(t-\tau))}+\sum_{(\tau=0)}^{r}\beta_2 \Delta C_{(i(t-\tau))}+\delta_0 Y_{(i(t-1))}+\delta_1 X_{(i(t-1))}+\delta_2 C_{(i(t-1))}+\varepsilon_{it}$ (2)

Where represents the endogenous variable, is the explanatory variable of interest, and is the vector of control explanatory variables. is the individual fixed effect, , and are respectively the short-run coefficients associated with the lags of the endogenous variable and the variable of interest and the control variables. , and are the long-run coefficients.
Where i=1,..., N and t=1,..., T represent the individual dimension and the time dimension respectively. (Δ) represents the first difference operator and denotes the error term. The short term relationship is represented by the coefficients to and the long term relationship is represented by the coefficients to, p,q and r represent the delay numbers.

4.1 Description of variables and data

This section presents, firstly, the variables used to measure energy poverty and, secondly, those adopted to capture participation in global value chains (GVCs).

5. Empirical results

5.1 Basic results

Following the estimation of the long-term coefficients, we can see the negative impact of energy poverty on the DRC's participation in global value chains, with a significance level of 1%. Higher energy poverty will lead to lower DRC participation in global value chains in the long run. As far as our control variables are concerned, trade openness and FDI have a positive impact, while financial development and gross fixed capital formation have a negative effect. Overall, the results show that energy poverty worsened the DRC's participation in global value chains. Such a result can be explained by the level of absolute poverty in the DRC, the under-industrialization, the low level of economic diversification etc. These results are consistent with the work of Chandio et al (2019) and Rasool et al (2020) which show that under-consumption of energy per capita, in particular electricity, is currently one of the most significant indicators of economic under-development. Moreover, production is the main problem in developing countries due to the lack of energy resources (Zhang et al, 2019).

Table 1. Energy poverty and the DRC's participation in global value chains

	GVC		
	(1)	(2)	(3)
	ARDL model		
VARIABLES	**ADJ**	**LR**	**SR**
L. Energy poverty		-0.0284***	
		(0.0069)	
L. Trade		0.955***	
		(0.177)	
L. Financial development		-0.424***	
		(0.134)	
L.lnFBCF		-0.144	
		(0.112)	
L. FDI		0.0380***	
		(0.0025)	
L. GVC	-0.276***		
	(0.0783)		
D. Energy poverty			0.0158
			(0.0432)
D. Trade			0.470**
			(0.0083)
D. Financial development			-0.0851*
			(0.0447)
D. FBCF			-0.0542
			(0.0406)
D. FDI			-0.0559
			(0.0706)
Constant			1.431***
			(0.475)
Observations	63	63	63
R-squared	0.437	0.437	0.437

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

5.2. Robustness of the effect using the sub-dimensions of value chain participation

The results of the robustness analysis with the Va-exp variable provided in Table 2 further reveal that energy poverty has a negative and statistically significant effect on the DRC's participation in global value chains. These results are consistent with those obtained in the basic model and the empirical literature. The results of the robustness analysis with the FVA variable provided in

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Table 2 further reveal that energy poverty has a negative and statistically significant effect on the DRC's participation in global value chains. These results are consistent with those obtained in the basic model and the empirical literature.

Table 2. Effect of energy poverty on Va-exp

	(1)	(2)	(3)
	ARDL model		
VARIABLES	**ADJ**	**LR**	**SR**
L. Energy poverty		-0.0182***	
		(0.0029)	
L. Trade		0.945***	
		(0.107)	
L. Financial development		-0.494***	
		(0.034)	
L. FBCF		-0.191	
		(0.132)	
L. FDI		0.0340***	
		(0.0025)	
L.Va_exp	-0.374***		
	(0.0791)		
D. Energy poverty			0.0152
			(0.0432)
D. Trade			0.430**
			(0.0083)
D. Financial development			-0.0841*
			(0.044)
D. FBCF			-0.0512
			(0.0406)
D. FDI			-0.0550
			(0.0700)
Constant			1.436***
			(0.479)
Observations	63	63	63
R-squared	0.407	0.407	0.407

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source: author

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Table 3. Effect of energy poverty on FVA

	FVA		
	(1)	(2)	(3)
		ARDL model	
VARIABLES	**ADJ**	**LR**	**SR**
L. Energy poverty		-0.0884***	
		(0.0039)	
L. Trade		0.995***	
		(0.107)	
L. Financial development		-0.404***	
		(0.104)	
L. FBCF		-0.184	
		(0.162)	
L. FDI		0.0330***	
		(0.0015)	
L. FVA	-0.576***		
	(0.0793)		
D. . Energy poverty			0.0189
			(0.0402)
D. Trade			0.479**
			(0.0083)
D. Financial development			-0.0854*
			(0.0217)
D. FBCF			-0.0242***
			(0.0006)
D. FDI			-0.0513
			(0.0106)
Constant			1.401***
			(0.412)
Observations	63	63	63
R-squared	0.537	0.537	0.537

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source: author

6. Conclusion

This paper examined the effects of energy poverty on the DRC's participation in global value chains over the period 1999-2020. Using the ARDL method. Two interesting conclusions emerge. First, energy poverty is found to have a negative effect on the DRC's participation in global value chains in the short term. Second, the negative effect of poverty on the DRC's participation in global value chains is confirmed in the long term, although the effects are different for upstream and downstream participation. These results confirm the hypothesized effect. The results of this study are consistent with the empirical literature.

What's more, our result remains stable even when we change the measure of participation in value chains. This shows that energy poverty handicaps the Democratic Republic of Congo's participation in upstream and downstream value chains. We conclude with suggestions for improving access to energy, income, and the need for more industrial enterprises to increase participation in GVCs.

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