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Economic Growth, Poverty and Energy Trends in Colombia: Long Run Relationship and Short Run Dynamics Effects

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Abstract:
This research analyses the long run and short run relationships among economic growth, poverty and energy using the Colombian case. In this study, we use the time-series methodologies. The results regarding the relationship among economic growth, poverty and energy show that increases in gross domestic product and energy supply per capita should lead a decrease of poverty, which should demonstrate that access to modern and adequate energy services help to decrease poverty and to increase economic growth. Moreover, the improvements in energy efficiency have contributed to increase economic growth from an approach of sustainable development. These results are important for the adequate design, formulation and application of policies and strategies that encourage a better energy use to improve economic growth and decrease poverty, especially in developing countries.

Keywords-- ***Economic development, Economic growth, Energy and Poverty;***

INTRODUCTION

A modern and reliable energy system is key strategy to improve economic growth, human development, labor market and quality of life, especially in developing countries. Several studies have evaluated the relationship between economic growth and energy. For example, Lee [36, 37] evaluates this relationship in developed and developing countries identifying that U.S. showed a bi-directional causality, whereas Canada, Belgium, Netherlands and Switzerland indicated uni-directional causality, and developing countries showed both relationships of causality; Balcilar et al. [4] evaluated the causality between energy use and economic growth in G7 countries finding no consistent causal relationship between these two variables; Ozturk et al. [49] used a panel data of economic growth and energy use for 51 countries recognizing that the relationship between these variables is no strong. These studies should demonstrate that there is no agreement about the direction of causality between energy use and economic growth measured as the gross domestic product. In Colombia, the studies on energy have shown different results. Castillo [10] identified that energy use does not play an important and clear role in productivity, and that economic growth is almost completely dependent on capital, [62–64] and [17] have demonstrated that the relationship between energy and gross domestic product (GDP) has shown a trend change from 2003 caused by greater efficiency in the process, change in the fuel used from low to high quality (i.e., from oil to natural gas), an increase in the process of the auto-generation of energy, and a higher contribution in the GDP of other activities with lower energy consumption such as construction and services activities. Energy sector has become recognized as key strategy to resolve social problems in Colombia such as poverty because this sector could generate a higher and adequate access to an energy system with more efficient and clean energy sources that should help to increase development, economic growth and productivity [62–64]. However, studies on the relationships among economic growth, poverty and energy are limited in Colombia. With this background, the objective of this paper is to examine the issue of

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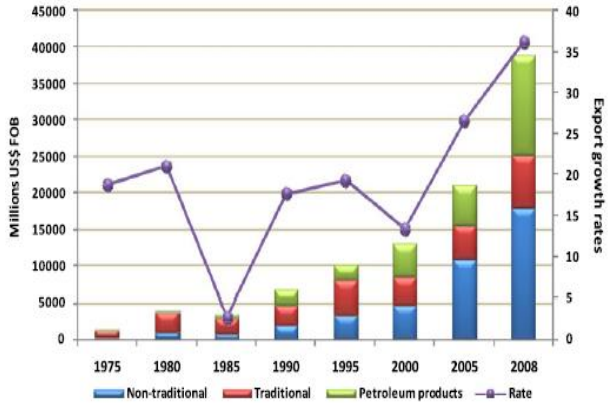
causality among economic growth, poverty and energy for Colombia during the sample period 1975–2008. This study contributes to the existing literature in the following manner. First, we intend to analyses the relationship between economic growth and energy while controlling for changes in the primary factors of production and other sources of growth, such as labor and exports. Second, this study includes variables of poverty and energy with the aim to understand the role of these variables in economic growth.



Source: Proexport

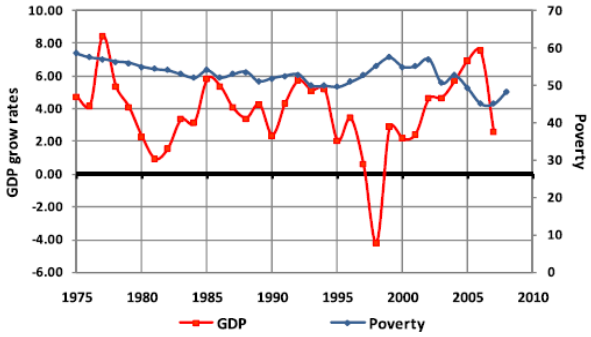
Fig. 1 Development of Colombian exportations

ECONOMIC GROWTH, POVERTY AND ENERGY TRENDS IN COLOMBIA

During the sample period, the Colombian economy has been rising considerably, despite the fragile conditions exhibited at the end of the 90s. Exportations and investment in conditions of ample liquidity and low interest rates achieved these improvements through consumption. Moreover, during the period 2006–2007 the Colombian economy had the best performance in three decades, surpassing the average for the South American region shown during the last five year an economic growth an average of almost 5% [9, 43]. Colombian exports have shown sustained growth since 1970 accompanied by high diversification in products (see Fig. 1). Indicators of the standard of living show that during the sample period poverty have not shown great changes, especially during the 90s and that poverty increased as a result of the economic recession of 1999. The percentage of Colombian population in poverty conditions decreased from 58.6% to 48.3% between 1975 and 2008 (see Fig. 2). However, from 2000, this relationship is unclear [23].

Energy matrix:-

Between 1975 and 2008, Colombian energy consumption has grown 78.2% with an average of inter-annual variation rates of 1.8% for energy consumption and 3.8% for GDP. Energy intensity in the last years has shown a decreasing trend as a result of technology change, urbanization and modernization, which have led a decrease in the use of firewood and its substitution by more efficient and clean fuels, the application of the rational-energy-use programmers and the increase of gas consumption could explain these trends [62–64]. Generally, economic growth has led to increased energy consumption.



Source: CEPAL and MERPD

Fig. 2 GDP growth rates and poverty in Colombia

However, the trends in GDP and energy consumption show a relative decoupling,3 although their trends are similar in the Colombian case (see Fig. 3). The relationship between energy consumption and GDP could be affected by substitution between energy and other inputs, technological change, shifts in the composition of energy sources and changes in the composition of output [59].

Poverty and Energy:-

In poverty reduction policies have predominantly strategies based on macroeconomic growth, large-scale infrastructure development and human capital investment. From this strategy, energy has been perceived as a sector that does not determine the decrease of poverty. On the other hand, the current

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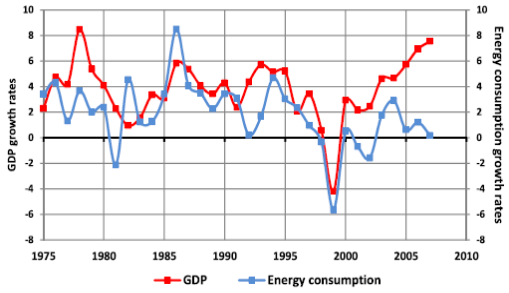
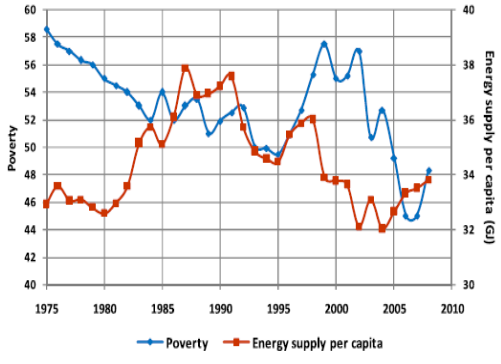
energy-poverty debate establishes that energy and poverty are related [8, 46].



Source: UPME and CEPAL

Fig. 3 Trends of energy consumption and GDP in Colombia

The trends of energy supply per capita have been increasing alongside the decrease in poverty (see Fig. 4) indicating the close relationship between the decrease in poverty and improvements in energy services where access to modern energy is a fundamental service that enables economic growth and contributes to the success of efforts to eradicate poverty [42]. Moreover, the United Nations, in its report "Road map towards the implementation of the United Nations Millennium Declaration, 2001", includes the following target: "Halve by 2015, the proportion of people without access to electricity and replace traditional biomass fuels by cleaner and more efficient energy sources.



Source: UPME and MERPD

Fig. 4 Poverty and energy supply per capita in Colombia

Whenever applicable, promote the use of renewable energies." This target integrates energy and poverty through goal 9 ("Ensure environmental sustainability") and goal 1 ("Eradicate extreme poverty"), provided that the lack of modern energy services is considered a central characteristic of poverty.

ESTIMATION RESULTS

The model used in this study is as follows (Output energy model):

$$\ln GDPt = \xi + \alpha \ln Labt + \beta \ln Expt + \delta \ln ESPCt - \gamma \ln EIt - \varphi \ln Povt \text{ --(a)}$$

Note that GDPt is the Gross Domestic Product, Labt is labour, EXPt are exports, ESPCt is energy supply per capita, EIt is energy intensity, and Povt is the poverty.

To test the order of integration of the variables we use the standard tests for unit root, namely the Augmented Dickey-Fuller (ADF), the Phillips-Perron (PP), Portmanteau and Bartlett's tests proposed by Dickey and Fuller [16], Phillips and Perron [55], Box and Pierce [7], Ljung and Box [39] and Bartlett [5] respectively. The results of the unit root test are reported in Table 1 indicating that the model must be estimated in levels.

Long run relationship:-

Equation (a) is estimated for Colombia using annual data covering the period of 1975–2008. Table 2 shows results of the long run. The selected model fulfils the standard diagnostic tests (serial correlation, functional form, normality and heteroscedasticity).

Table 1 Results for stationarity—unit root test. Output–energy model

	Dickey Fuller Test		Phillip-Perron Test		Portmanteau Test		Bartlett's Test	
	Level	1st Difference	Level	1st Difference	Level	1st Difference	Level	1st Difference
GDP	−0.517	−3.518	−0.500	−3.569	129.65	21.68	2.581	1.520
	(0.888)	(0.0075)	(0.892)	(0.006)	(0.00)	(0.085)	(0.00)	(0.019)
Labour	−3.875	−3.916	−3.906	−3.600	135.28	18.34	2.800	1.277
	(0.002)	(0.006)	(0.007)	(0.005)	(0.00)	(0.191)	(0.00)	(0.079)
Exports	−0.400	−5.342	−0.505	−5.315	119.52	7.855	2.371	0.480
	(0.871)	(0.00)	(0.874)	(0.00)	(0.00)	(0.896)	(0.00)	(0.975)
Energy supply	−1.666	−5.590	−1.780	−5.593	128.9	5.035	2.975	0.202
per capita	(0.448)	(0.00)	(0.300)	(0.00)	(0.00)	(0.985)	(0.00)	(1.00)
Energy	1.414	−3.969	2.091	−4.031	96.18	10.845	2.376	1.069
Intensity	(0.997)	(0.0016)	(0.998)	(0.001)	(0.00)	(0.698)	(0.00)	(0.202)
Poverty	−2.461	−3.465	−2.095	−5.902	42.94	9.356	2.216	0.657
	(0.120)	(0.008)	(0.246)	(0.00)	(0.00)	(0.807)	(0.00)	(0.780)
Critical Value (at 5%)	(−2.98)	(−2.98)	(−2.98)	(−2.98)	P- value ≤ 0.05	P- value ≥ 0.05	P- value ≤ 0.05	P- value ≥ 0.05

The results show that the impact of labour on output is positive (0.063) and marginally significant at the 1% level. The estimate of the coefficient of exports (0.014) is positive and marginally significant at the 5% level

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suggesting that exports flows of Colombia have a stimulating effect on growth. The estimate of the Energy supply per capita bears a positive sign (0.883) and is significant at the 1% level indicating that economic growth drives energy consumption.

Dependent variable: real GDP

Variables	Coefficients	Stand. error	*t*-ratios	*p*-values
Constant	0.424**	0.173	2.45	0.021
Labour	0.063***	0.016	3.76	0.001
Exports	0.014**	0.006	2.33	0.027
Energy supply per capita	0.883***	0.032	27.08	0.000
Energy Intensity	−0.911***	0.021	−43.33	0.000
Poverty	−0.019	0.014	−1.39	0.175

Notes: *Significant at the 10% level, **Significant at the 5% level, ***Significant at the 1% level

Table 2 Estimated regression model—estimates of the long run coefficients. Output-energy model

The energy intensity variable affects negatively (0.911) real GDP in Colombia. The estimated coefficient is highly significant. Finally, the poverty does not seem to have a significant effect of real GDP. The estimated coefficient is negative (−0.019) and statistically insignificant.

Short run dynamics:-

Table 3 summarises the results of cointegration tests. The absolute values of the calculated test statistics for all the residuals and CRDW are less than its critical value at the 5% level indicating that neither of the series are cointegrated. Therefore, the standard Granger test [24] is adequate. These results are confirmed by the Johansen likelihood ratio test. The likelihood statistics (r = 0) are all well below the 5% significance level values indicating the acceptance of the null hypothesis. The results of causality test are reported in Table 4 indicating that growth in the labour, exports and energy supply per capita significantly affect economic growth. The variables in the model are cointegrated indicating that is adequate the use of an error correction model mechanism (ECM) representation in order to evaluate the short run dynamics (see Table 5). The estimated results of the model are reported in Table 6. The Adj-R2 is 0.97 suggesting that such error correction model fits the data reasonably well. More importantly, the error correction coefficient has a negative and highly significant sign. This result confirms a long run relationship among the variables in this model. The effect of labour is positive on economic growth suggesting that the role of labour in economic growth has been mostly driven by the human capital component, with raw labour playing a secondary role, which concurs with studies of economic growth in Latin American and Colombian context [11, 14, 40, 43]. In the case of exports with positive and significant effect on economic growth, the results could be explained by the dynamics of Colombian exports, which, during the sample period, were characterised by growth, deceleration and diversification (exports per capita grew at an average rate of 15.5% in the 1970s, when the economy was growing, despite the fact that deceleration almost tripled between 1990 and 2005 [43]). According to the measure of export sophistication, EXPY, proposed by Haussmann et al. [26] the level of Colombia's current export basket sophistication appears moderate but is increasing over time. However, overall export growth has not been enough to result in the sustained growth of exports as a share of GDP, and place country region Colombia's exports are small relative to the size of its economy [27].

Null Hypothesis	*F*-Value	Probability	Decision
Growth in labour force does not cause growth	10.5	0.0004	Rejected
Growth in exports does not cause growth	5.29	0.0110	Rejected
Growth in energy supply per capita does not cause growth	4.13	0.0264	Rejected
Growth in energy intensity does not cause growth	6.66	0.0042	Rejected
Growth in poverty does not cause growth	9.10	0.0009	Rejected

Table 4 Granger test for causality. Output-energy model

Variable	Dickey Fuller Test	Lags	Bartlett's Test	Portmanteau Test
Residual	−6.145	0	0.45	13.592
	(0.000)		(0.986)	(0.556)

Table 5 Test residuals

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Dependent variable: real GDP				
Variables	Coefficients	Stand. error	*t*-ratios	*p*-values
Constant	0.000	0.001	0.66	0.513
Labour	0.043	0.030	1.42	0.168
Exports	0.016***	0.005	2.93	0.007
Energy supply per capita	0.871***	0.040	21.35	0.000
Energy Intensity	−0.882***	0.035	−24.99	0.000
Poverty	−0.018	0.018	−0.99	0.330
Residual (-1)	−1.089***	0.201	−5.40	0.000
Adj-R-squared	0.97			
F-value	212.52			

Notes: *Significant at the 10% level, **Significant at the 5% level, ***Significant at the 1% level

Table 6 Estimated regression model—estimates of the error correction representation. Output-energy model

The poverty variable has a negative effect on output indicating the importance of these variables in economic growth. Poverty reduction depends on the growth of average income and on how income is distributed and is closely linked to the sensitivity of poverty to [6, 12, 13, 32, 41, 56, 57]. Energy supply per capita positively affects economic growth. The variable of energy intensity shows that trends in energy prices, energy policies and technologies have achieved to reduce energy to produce a good during the sample period. Colombia as a developing country shows a moderate technology level with great potential to adopt new technologies to aim of increasing productivity and optimising energy consumption [51, 52, 61]. From the above results, we can see that higher economic growth increases energy supply per capita and decrease poverty. Designing, adopting and implementing policies focused on providing affordable, clean and reliable energy acts should generate economic growth and poverty reduction because access to energy services generates incomes and employment and can help to achieve a more sustainable use of natural resources and improvements in quality of life of population [67].

CONCLUSIONS

In this paper, we studied the direction of the causal relationship between economic growth, poverty and energy in Colombia. Moreover, other variables were analyzed such as exports, poverty and energy intensity on economic growth. The methodology used included the Granger causality test, which has been found appropriate by using the co-integration technique and discovering there is no co-integration between the variables concerned. The results of the long run relationship and short run dynamics show that the effect of labor and exports are a positive effect on output. Also, these two variables are significant in the long run. Exports show the dynamic of this variable in Colombia that during the sample period was characterized by growth, deceleration and diversification. The poverty variable has a negative on output, indicating the importance of this variable for economic growth. Energy intensity has a negative effect on output, showing that improvements in energy efficiency have contributed to increase economic growth from an approach of sustainable development. The results of energy supply per capita show that this variable contributes in the increase of economic growth, whereas poverty contributes in the decrease of economic growth. From this analysis, we can see that economic growth led energy supply per capita and could contribute in improvements of standard of living. In order to achieve high economic growth and decrease poverty, multidimensional policies are required. These policies should not ignore the energy sector or sustainable development. In future research will be important include the long run relationship and short run dynamics of economic growth, energy and pollution taking into account the environmental impacts caused by the different fuels used to produce energy and the effects of fuel substitution in the trends of energy use, energy intensity and economic growth.

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