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Energy

A Perspective on Energy Consumption Balance: Quality of Life, Governance, and Carbon Emissions in APEC

Narayan Sethi[1] [a], Devi Prasad Dash[2]

[1] Humanities and Social Sciences, National Institute of Technology Rourkela, India, [2] School of Management and Entrepreneurship, IIT Jodhpur, India

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We estimate the impacts of energy-led growth, quality of life, and institutional factors on carbon emission intensity. Utilizing a balanced panel of 21 Asia-Pacific Economic Cooperation (APEC) economies, we show that energy-led growth contributes heavily toward emissions. We also demonstrate that improved transparency help decimate pollution significantly. However, we find that improved human development and employment exert a direct influence on pollution, thus isolating the impacts of growth in the long run. These findings typically demonstrate unsustainable development in the region, thus requiring a complete revamping of the policy framework.

I. INTRODUCTION

In contemporary times, sustainable development is the key to economic growth and development. Rising oil prices and perpetually increasing emissions of greenhouse gases due to burning fossil fuels require urbanization to take into account the minimization of the use of resources and increasing energy efficiency (Chau et al., 2015; Liao et al., 2015). Unconstrained extraction of fossil fuels coupled with increasing rates of population growth have detrimental effects on human life, such as climate change and associated diseases. Energy usage and energy consumption need to be viewed in close conjunction with quality of life to understand their net effects. Various indicators of the quality-of-life index are observed to be highly correlated with energy and electricity consumption per capita (Mazur, 2011). Energy consumption is closely associated with land use patterns, transportation, and population density (Liu et al., 2016). Moreover, access to energy is a pre-condition for employment opportunities, access to health and education services, and consequently poverty reduction (Nadimi & Tokimatsu, 2018). Al-Mulali (2016) reports an improvement of 70% in the quality of life in 198 countries, irrespective of their differences in income. Levels of energy consumption are also observed to play a significant role in the determination of the Human Development Index and the level of sustainable income (Van Tran et al., 2019). Yumashev et al. (2020) find that the volume of energy consumption not only affects the human development index in a particular country, but is also an important factor in determining the level of sustainable development. A recent study by Oluoch et al. (2021) finds that renewable energy consumption is significant and positively correlated with the gross domestic product (GDP) per capita and the education index in the long run, as expected, whereas renewable energy consumption is significant and negatively correlated with CO2 emissions per capita and the life expectancy index in the long run.

Specifically, the Asia-Pacific Economic Cooperation (APEC) region comprises 39% of the world's population and 54% of the worlds' GDP. In addition, the APEC region alone was accountable for 58% percent of the global primary energy supply and 57% of energy consumption around the world in 2016. Moreover, this region is also observed to include the four largest energy users in the world, that is, China, Japan, Russia, and the United States (APEC, 2019). With rising levels of industrialization and increasing rates of migration from rural to urban areas, energy consumption is expected to surge in the coming years. The final energy demand of APEC continues to be dominated by fossil fuels, which comprises 64% of final energy demand. However, several factors, such as active government policies for clean energy, price drops in renewable technologies, and cheaply available natural gas, aid in the declining demand for coal in this region. Electric energy access, subjective well-being indicators, local capabilities, and participatory decision-making processes are quintessential in assessing the interaction between electric energy consumption and the quality of life (Castro-Sitiriche & Ndoye, 2013).

[a] **Corresponding Author:**
Narayan Sethi, nsethinarayan@gmail.com
Humanities and Social Sciences, National Institute of Technology Rourkela

Table 1. Definition and Measurement of Variables

Variables	Full Name	Definition	Unit of measurements
CO2	Carbon emissions	Emission of pollutants in terms of carbon dioxide.	Metric tons
EC	Energy Consumption	Total amount of consumption of different forms of energy.	Exo-joules
Trans	Transparency	Transparent governance with predictable enforcement.	In index score from 0 to 1
GDP	Gross Domestic Product	Total final value of goods and services produced in an accounting year.	In constant US dollars
LFPR	Labour force participation	Total employment	In terms of percentage of total population
Int	Internet	Accessibility of internet services to the people.	per 100 people
TT	Travel	Inflows of tourists	In numbers
HDI	Human Development Index	Measuring country's achievement in social and economic dimensions.	In index score from 0 to 1
Life	Life expectancy	It is the life expectancy at bierth in terms of years.	In numbers
Corr	Corruption	Perspectives on different forms of corrupt practices.	In index score from 0 to 100

Notes: This table shows definitions and measurements of the variables used in our analysis. Author's own compilation of information.

This study contributes to the energy literature in two ways. First, we contribute to the literature in terms of correlating governance, transparency, and corruption aspects to the emission intensity of the APEC region. Second, the implications of energy consumption–pollution dynamics have been analyzed by utilizing quantile and threshold regressions, which imply examining regional emissions at different intervals and utilizing governance as a threshold indicator in the region. This paper seeks to contribute to the energy literature differently from the standpoints of the quality of life and governance, since both factors help incentivize sustainable energy consumption and to better control emissions.

The remainder of the paper is structured as follows. Section II discusses the potential data, empirical methods, and findings of the paper. Section III concludes the paper.

II. DATA, METHODS, AND RESULTS

A. Data Collection

This study considers the data on carbon emissions, energy consumption, transparency, the GDP, employment, travel, Internet availability, human development, life expectancy, and corruption for 21 APEC economies from 1995 to 2019. We use the natural logarithm of these measures to avoid spurious regression issues. Data on transparency are obtained from the World Bank's World Governance Indicators database, while the information on the rest of the variables obtained from the APEC database. Table 1 reports the details of the variables. The data for all the variables in the model are on an annual basis.

B. Empirical Framework

The study uses the following empirical model:

$$\begin{aligned} CO2_{it} = {} & \alpha_1 EC_{it} + \alpha_2 Trans_{it} + \alpha_3 GDP_{it} \\ & + \alpha_4 LFPR_{it} + \alpha_5 Int_{it} + \alpha_6 TT_{it} \\ & + \alpha_7 HDI_{it} + \alpha_8 Life_{it} + \alpha_9 Corr_{it} \\ & + \varepsilon_{it} \end{aligned} \quad (1)$$

where $CO2$ is the main outcome variable and EC, $Trans$, GDP, and $LFPR$ are the major explanatory variables. The rest of the variables include control variables, such as internet availability (*Int*), travel human development (*TT*), life expectancy (*Life*), and corruption (*Corr*), and *I* and *t* denote the 21 APEC economies and the years 1995 to 2019, respectively. The term ε_{it} is the stochastic disturbance. The major objective of this study is to estimate α_1, α_2, α_3, and α_4 in model (1). We expect energy consumption and the GDP to contribute positively to energy consumption, and transparency to impact emissions negatively. Other control variables, such as labor force participation, human development, and corruption, are expected to impact carbon emissions positively over the years.

We estimate equation (1) by utilizing ordinary least squares estimates followed by quantile regression (Koenker & Bassett, 1978). Quantile estimates enable us to examine the effects of carbon emissions in the region at different intervals. Furthermore, following Hansen (1999), we estimate the threshold regression model by utilizing transparency as the threshold variable.

C. Results

The regression results are displayed in Table 2. The coefficients of energy consumption are statistically significant and positive. There is further evidence of a positive association between corruption and emissions in the region, while improvements in transparency in governance notably help decrease pollution. Further robust evidence is obtained from the positive relation between human development, labor force participation, and carbon emissions. Overall, the trend reflects unsustainable growth in the region coupled with institutional failures.

Next, we focus on the variance of emission intensity as a measure of emissions, where growth and institutional factors can have different levels of appeal on the empirical front. We find that the coefficients of energy consumption

Table 2. Regression Estimates

CO2	I	II	III	IV
EC	0.156*	0.291*	0.166*	0.242*
	(0.011)	(0.047)	(0.011)	(0.045)
Transparency	-0.116*	0.079*	-0.122*	0.096*
	(0.023)	(0.028)	(0.024)	(0.026)
GDP	-0.057*	0.005	-0.066*	0.001
	(0.020)	(0.004)	(0.022)	(0.001)
LFPR	0.423*	-0.282*	0.498*	-0.009
	(0.175)	(0.117)	(0.178)	(0.008)
Internet	-0.010	0.016*	0.102*	0.055*
	(0.009)	(0.007)	(0.025)	(0.009)
Travel	-0.088*	-0.008	-0.315*	0.037**
	(0.019)	(0.007)	(0.058)	(0.020)
HDI	3.416*	0.869*	3.164*	1.273*
	(0.133)	(0.177)	(0.136)	(0.174)
Life expectancy	-3.720*	-2.518*	-3.634*	-0.959**
	(0.445)	(0.510)	(0.538)	(0.521)
Corruption	0.108*	0.009	0.101*	0.076*
	(0.015)	(0.007)	(0.035)	(0.016)
Constant	4.508*	5.473*	4.398*	1.607***
	(0.705)	(0.915)	(0.755)	(0.697)
Time Effect	No	No	Yes	Yes
Country Effect	No	Yes	No	Yes
R^2	0.825	0.901	0.846	0.903
F test	271.24*	609.86*	81.72*	576.78*

Notes: This table shows the regression estimates. (*), (**) and (***) indicate the levels of significance at 1%, 5% and 10% respectively.

are positive and significant at the 1% level (see Table 3). As mentioned above, we also note that corruption and declining institutional quality result in higher emissions.

There is little evidence of a positive association between human development and employment and pollution across quantiles. This necessarily suggests that rising human development in terms of income growth leads to more lavish expenditures and negates green growth. Other empirical evidence on growth and internet availability do not show any substantial significant relation with the rate of emissions.

Considering transparency as the main threshold variable, we propose a single-threshold model with emissions as the outcome variable. Our analysis suggests that energy consumption in the existing phase is positively influencing emissions. The GDP exhibits no significant impact on emissions due to differences in environmental standards and regulations (see Table 4). Improved human development and employment exert positive impacts on carbon emissions, as evident from existing and previous models. Surprisingly, we note two areas of divergence from our earlier findings. First, considering transparency as a threshold variable, the impact of corruption on emissions is almost nonexistent. Second, we find two different results in terms of a positive and a negative significant association between human development, life expectancy, and emissions. This is solely because the APEC region has a large young to middle-aged working population spending more on luxuries.

III. CONCLUSION

In this study, we test the asymmetric impacts of growth, energy consumption, human development, and institutional factors upon the carbon emissions for the APEC region. In terms of mechanisms, the results suggest that regional economies need to achieve sustainability, especially in terms of human development and employment. Our results surprisingly reveal that a rise in human development and employment results in higher emissions. In addition, improvements in governance and facilities such as tourism are essential to attain sustainability in the long run. Our overall findings show that reforms at the institutional level and other developmental fronts need to ensure sustainability to control pollution, in addition to reforms in the energy sector.

Table 3. Quantile Regression

CO2	I	II	III
EC	0.223*	0.162*	0.116*
	(0.019)	(0.014)	(0.014)
Transparency	-0.102*	-0.066*	-0.143*
	(0.040)	(0.029)	(0.029)
GDP	-0.032	-0.018	0.005
	(0.031)	(0.016)	(0.005)
LFPR	0.670*	0.055	0.685*
	(0.300)	(0.047)	(0.216)
Internet	-0.037	-0.019	-0.012
	(0.029)	(0.017)	(0.011)
Travel	-0.064**	-0.070*	-0.086*
	(0.034)	(0.024)	(0.024)
HDI	2.959*	3.133*	3.985*
	(0.228)	(0.164)	(0.173)
Life expectancy	-1.398**	-3.507*	-3.945*
	(0.762)	(0.550)	(0.549)
Corruption	0.125*	0.102*	0.050*
	(0.025)	(0.018)	(0.018)
Constant	-0.086	4.942*	3.838*
	(0.083)	(0.872)	(0.370)
Quantiles	25^{th}	50^{th}	75^{th}
Pseudo R^2	0.638	0.612	0.593

Notes: This table shows the quantile regression estimates. (*), (**) and (***) indicate the levels of significance at 1%, 5% and 10% respectively.

Table 4. Threshold Regression

CO2	I	II	III	IV
EC	0.276*	0.271*	0.243*	0.281*
	(0.037)	(0.032)	(0.022)	(0.047)
Transparency	-0.121*	-0.111*	-0.101*	0.015
	(0.024)	(0.020)	(0.013)	(0.014)
GDP	0.007	0.007	0.005	0.008
	(0.006)	(0.006)	(0.004)	(0.007)
LFPR	0.224*	0.214*	0.188*	0.243*
	(0.086)	(0.074)	(0.074)	(0.111)
Internet	0.012*	0.011*	0.011*	0.016*
	(0.006)	(0.004)	(0.003)	(0.007)
Travel	-0.002	-0.002	-0.001	-0.008
	(0.002)	(0.002)	(0.001)	(0.006)
HDI	0.321*	0.301*	0.281*	0.864*
	(0.140)	(0.122)	(0.102)	(0.175)
Life expectancy	-1.100*	-0.993*	-0.976*	-2.556*
	(0.407)	(0.367)	(0.359)	(0.504)
Corrupt	-0.005	-0.005	-0.005	0.008
	(0.004)	(0.004)	(0.004)	(0.006)
Constant	2.498*	2.122*	1.896*	5.121*
	(0.729)	(0.663)	(0.557)	(0.899)
Threshold variable	Transparency	Transparency	Transparency	Transparency
Trimming	0.01 0.01 0.01	0.05 0.05 0.05	0.10 0.10 0.10	0.25 0.25 0.25
R^2	0.505	0.493	0.481	0.428
F test	89.24*	89.10*	86.70*	40.40*

Notes: This table shows the threshold regression estimates. (*), (**) and (***) indicate the levels of significance at 1%, 5% and 10% respectively.

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