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Evidence from the BRICS Nations on Empirical links between ICT, Tourism, and Commerce in the Pursuit of a Sustainable Environment

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Abstract - Information and communication technology (ICT) sustainability is a topic of vigorous and sophisticated academic discussion. Utilizing the Environmental Kuznets curve (EKC) theory, this study examines whether technology for communication and information, economic expansion, and financial growth affect carbon dioxide emission in the BRICS countries. The Methods for Moments - Quantile Analysis was used to do this, and the outcomes indicate that the impact of the variables that explained the results varied according to the quantile of CO2 emission. The overall findings indicates that, but information and communication technology (ICT) mostly reduces emissions at lower emission quantiles, economic expansion and financial growth increase the amount of CO2. It studies that match the EKC hypothesis along with it. It's noteworthy to see that the amount of the effects of information and communication technology and economic growth on carbon dioxide emissions are smaller. The findings of the causality test demonstrate that any policy change influencing the explanatory variables has a significant influence on carbon dioxide emissions and vice versa, demonstrating bidirectional causation between the model parameters. Policymakers may now build a framework for accomplishing the Sustainable Development Goals based on the findings.

Keywords - ICT, BRICS, tourism, sustainable environment

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INTRODUCTION

Technology for information and communication is crucial to achieving the Sustainable Development Goals, based to the 2019 background document released by the Team on Science, technology, and innovations for the development. Given the nations' current path of global economic growth, information and communication technology (ICT) is presently considered as a tool for fostering innovation. ICT was additionally identified as an essential tool for encouraging creativity in the effort to attain the SDGs internationally in a very recent assessment undertaken by the International Telecommunications Union, or by utilizing ICT effectively, with technological transfer, countries that are developing may embrace knowledge and information, increasing global connectivity and strengthening their competitive edge (Destek and Sinha (2020).

The role of information and communication technology in the issue of environmental degradation

The topic of information and technology dissemination appears to be of greater significance with reference to the global warming, which may be indicated as the minor ecological impact by the rapid rate of economic growth that countries have managed to achieve. If we wish to change our current development trajectory, we have to recognize the importance of innovation. According to a research by the Climate and Development Knowledge Network, which is ICT innovation offers the potential to help worldwide efforts to address environmental deterioration. Refocusing environment and innovation policies is required for guarantee (Fernandez et al., 2015). It is equally essential to remember that the use of ICT may be difficult in the developing economies. The increasing number of nations' insistent on attaining financial growth, even at a cost of environmental value, is one for the key motorists of this. Examining the patterns of economic growth in these nations shows that petroleum and natural gas are the main driver of this expansion; this scenario may be related to the renowned League of Rome economists. The depletion of natural resources may have an impact on the pattern of economic growth if we keep depending on solutions based on fossil fuels. Achieving the Sustainable Development Goal (SDG) of delivering clean and inexpensive energy may become easier for countries under these scenarios as ensuring energy security must become taking on tasks. The ability of a nation to protect its natural resources may be endangered by ongoing reliance on fossil fuels, which will make it challenging to meet SDG 13's objectives for action on climate change. In this situation, economic reorientation may be necessary for the developing economies so that they

can get towards realizing Agenda 2030 (Meadows et al., 1972).

Proposing out an SDG framework for the BRICS nations

In the context of achieving innovation-driven economic development for underdeveloped countries, the 11th BRICS Summit merits special attention. Due to ongoing developmental challenges, these countries have started to take into account a variety of scientific innovation fronts in their attempts to get towards reaching the SDG objectives. It is also ensured for sustainable growth in their nations. The declaration was justified by the worsening climate issues in those countries as well as issues with financialization of policymaking. To promote creativity, development and research requires financial assistance. The United Nations Environment Programme has released a research on SDG financing, which suggests that BRICS nations might find it difficult to allocate cash (Ansar et al., 2015; Sharif et al., 2020).

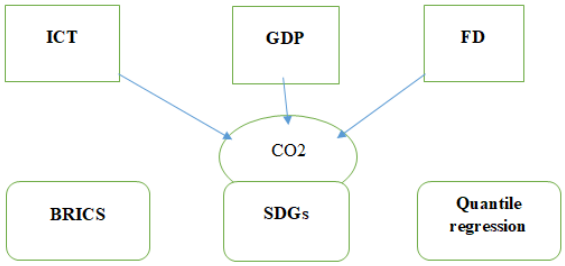


Figure 1: Conceptual framework

When developing an effective policy-oriented approach, the impact is inherently adaptive since the nature of the influence of policy tools on the target policies variable may change over time according to the external socio-political situation. As a result, this study's analytical approach, which will take into thought how policy instruments' effects evolve over time, must be able to account for this natural influence. To accomplish its objective, this study employed the Environmental Kuznets Curve (EKC) hypothesis. Because there are organizational similarities and transaction spillover throughout the research contexts, this framework can describe the development of policy tools. This may help in identifying the separate impacts of different cross-sectional groups. For that reason, affirmative quantile evaluations offer data that conditionally mean estimations cannot adapt to (Sharif et al., 2020; Suki et al., 2020).

Quantile estimation technique: Method of moments

By using quantile estimation technique, unique outcomes are produced at different tiers of the target policy variable, and distributional variability is empirically established. The structural motion of the BRICS states may be described as distributional differences, which may be the fruit of transactional spillovers among the countries involved. As a policymaking perspective, this holistic approach to policymaking encourages the research challenge in a number of ways. In the beginning, unlike conditional means estimates, that are susceptible to the deceptive impact caused by outliers. Another issue is that policy instruments' distributional impacts on the target regulatory variables aren't taken into account by unconditional mean estimations. Conversely, quantile regression provides further logical defence, particularly in panel data regression analyses, because this method separates the distributional have an impact of the explication variables on the explained items via distinct quantile arrays. This aids in establishing the scope of the various effects of various cross-sectional teams. Therefore, the information offered by conditionally quantile estimations cannot be obtained through conditionally mean estimates. The above discussion leads to the assumption that the use of MMQR provided the study's innovative contribution (Koenker, 2004).

LITERATURE REVIEW

The preceding research explains how ICT and growth drivers affect CO2 emissions.

ICT's impact on CO2 emissions

When accounting for the direct-indirect rebound effect, the EKC may be utilized to evaluate the impact of ICT. The immediate effects of ICT development are in line with the CO2 emissions (Koenker, 2004). Indirect effects shows that the ICT industry has a greater energy intensity that other industries (Malmodin and Lundén 2018). Improvements in energy efficiency are frequently evaluated using the rebound effect that may be done from an ICT point of view (Romm, 2002). The potential benefits of ICT development that aim to increase energy efficiency or have a direct influence on the ecological balance are regarded to be diminished as a result of the financialization of ICT. Demand for other products will increase when a product's energy use improves due to direct rebound impacts (Gossart, 2015). When ICT accelerates an organizational revolution in national consumption patterns and end-to-end supply chain processes, cross-national rebound effects occur. These factors have been taken into consideration in studies which shows the interaction between ICT and the environment (Bieser and Hilty 2018). The disadvantage illustrates that as a result of rising energy consumption, greater industrialization brought about higher levels of environmental pollution. Moyer and Hughes' 2013 study looked at 193 different countries' ICT, economic development, and emission relationships. Their research showed this, while the relationship between ICT and environmental effects is minimal in the immediate future, it is significantly linked in the long term (Latif et al., 2018). The relationship between ICT and environmental pollution in low-income nations and

environmental deterioration in high- or middle-income countries was examined using regional panel data from 1979 to 2017 (Saud et al., 2019).

According to **Ulucak et al. (2020)** Technology's contribution to CO2 emissions for BRICS economies between 1995 and 2012 is examined thoroughly.

Avom et al. (2020) demonstrated that ICT lowers CO2 levels. Its impact on environmental degradation in Sub-Saharan African economies was also studied by Avom et al. They discovered that it increases CO2 level.

Faisal et al. (2020) examined the hypothesis that, ICT lowers environmental pollution many countries.

Godil et al. (2020) from Pakistan provided evidence that ICT decreases environmental pollution.

Higón et al. (2017) stated that ICT causes environmental pollution up to a certain point and then demonstrates a minor connection with pollution after that point.

Ishida (2015) shown using Japanese time-series statistics show that, although having little connection to economic growth, ICT has a negative impact on energy use.

Zhang and Liu (2015) suggested adopting ICT from 2000 to 2010 to lessen environmental pollution in China.

Effect of CO2 emissions' financial development

Financial development can offer financial assistance to sectors that employ less-polluting and environmentally friendly technology with the goal to enhance environmental quality. Financial growth may lead to a rise in foreign investment, which would increase the amount more cutting-edge technologically driven research and development being conducted with the goal of improving environmental quality (Le and Ozturk 2020). On the other hand, revenue growth helps companies improve their manufacturing processes that have caused industrial pollution and an improvement in environmental quality. While there is presently conflicting data on economic prosperity and degradation, some findings have found an advantageous relationship between the two. Using information from eight developed and eight developing nations, it looks at how easy access to finance leads to the expansion of industrial units, which raises CO2 levels due to financial development. Financial development produced data that was inconsistent with the linearity technique used in the prevalent literature. It is logical to assume that the impacts of economic growth differ depending on CO2 levels. The positive impacts of financial development on revenue growth through capital accumulation, technical advancements, and the expansion of investment resources have been demonstrated empirically in a number of recently conducted empirical studies (Shahbaz et al., 2013)

Economic expansion and CO2 emissions

The rate of environmental deterioration slows down beyond a certain point in economic development, and further revenue growth raises environmental standards. Environmental deterioration, including water and soil pollution and ambient air pollution, rises during the early phases of economic growth. The connection between pollutants and wealth is represented by the EKC connections that initially displayed a U-shaped inversion among income inequality and economic development. Various empirical investigations of the EKC idea have shown varied and broad findings (Zafar et al., 2019). The present research eventually yields conflicting and misleading results since it uses a variety of samples, time periods, and approaches. It's noteworthy to note that the majority of earlier research has only used conventional linear approaches, which do not take distributional variability into consideration when producing estimates. Furthermore, EKC's multidimensional modelling of the BRICS nations does not account account the link among environmental health, economic growth, information and communication technology, and CO2. This study examines the impacts of ICT, economy growth, and GDP at different amounts of carbon dioxide emission using our just-released MMQR (Al-Mulali et al., 2015).

RESEARCH METHODOLOGY

A more comprehensive look at the BRICS nations finds strong growth in the economy driven mostly by fossil fuel-based technology. Given the economic growth pattern's supremacy and the steady increase in CO2 emissions it generated in several nations, politicians are now trying to regulate how people use energy (Zafar et al., 2019). As a consequence of this change, these countries must innovate more, reduce their reliance on a manufacturing-based secondary industry, and promote the development of the ICT-enabled higher sector. The current economic growth trajectory has to be significantly catalyzed so as to promote the efforts underway to generate ICT-based innovations. The catalyst for change must occur in the form of financial support for the housing industry in order that it can be provided with innovative, freshly produced electrical options that reduce carbon dioxide emissions. The acceleration of financialization must be accompanied with the development of sectors. The Economic Growth Hypothesis framework theoretically captures this natural impact, since the terms lined and linear in per capita income capture the combination of composition and dimensions effects of economic growth (Zafar et al., 2019; Al-Mulali et al., 2015).

Data collection and selection of samples

This research examines the impact of ICT and FD for developing or going carbon dioxide carbon dioxide emissions, take into consideration the income-induced EKC concept in the BRICS

countries. These nations were selected because they share traits, such young population and similar rates of development. Another significant feature that binds these nations together is how close they are to wealthy countries geographically. The present research examines how Technology and FD contribute to increasing or going CO2 levels while additionally taking the BRICS nations' income-induced EKC theory into account. These countries were selected as they share traits, such youthful population and similar levels of development. Another significant trait that ties these countries together is their proximity to wealthy countries geographically.

Table 1: Description of the Components

Symbols	Variables	Description	Sources
ICT	Information and communication technology	Internet users as a percentage of the population.	WDI
CO2	Carbon dioxide	Carbon dioxide (A metric tons of oil equivalents per individual)	BP
FD	Financial growth	GDP is the percentage of domestic credit to the private sector.	WDI
GDP	Economic growth	Gross domestic product	WDI

Aggregate analysis

The total analysis for the model variables are shown in Table 2. The majority of the data set's symmetry may be seen in Table 2. The variables are GDP, ICT, CO2 and FD. They are represented with different mean, median, maximum and minimum values.

Table 2: Statistics Analysis values

Components	Mean	Median	Highest value	Lowest value
GDP	2120.434	2234.679	3430.678	6480.783
ICT	2.456	15.577	34.567	0.022
CO^2	22.467	5.467	3.678	3.567
FD	32.436	42.567	35.357	45.454

Pedroni's FMOLS technique effectively handles these issues by taking into account individual-specific intersections and addressing the features of uneven serial correlation of error-prone handles all through the panel. The quantile regressions are even more dependent on the existence of exceptions during analysis. Additionally, this method performs well when there is little to no relationship among the conditioned means between the two elements. Low-cost loans provided by an established banking industry enable businesses to adopt energy-efficient technologies and lower CO2 emissions. The key issues when evaluating dynamical cointegration of panels involve heterogeneity, as indicated by variations in longitudinal means as well as variations in longitudinal adjustment to the cointegrating equilibrium.

RESULTS

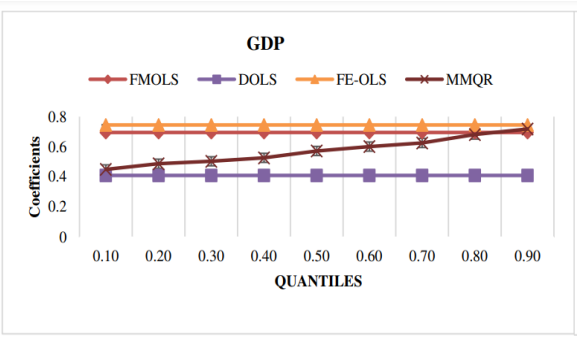
Applying the Im-Pesaran-Shin and Breitung tests, a first-generation stationarity test was performed, demonstrating that all variables are stationary at the first difference. Thus, any additional estimating techniques should include thorough handles for assessing the dependency and ought to eliminate any possibility of size fabrications. The cross-sectional Im-Pesaran-Shin and Herwartz & Siedenburg unit root tests that effectively address the CD issue and ensure that all of the model factors are integrated of order, are employed to comply with the same standard. Yet the impact of ICT on lowering emissions wanes because Internet-related systems and gadgets consume more energy. ICT raises emission quantiles, which has a negative but negligible effect on lowering emissions overall.

Table 3: Results of Stable Assessment values:

Components	Im, Pesaran and Shin	Breitung
ICT	0.346	0.338
CO2	1.343	1.344
FD	0.383	1.744
GDP	1.363	1.329

The results of the MMQR estimator are shown in Table 4. The findings demonstrate a positive with substantial correlation between GDP and CO2 emissions across all quantiles, suggesting that GDP expansion could promote larger emissions by catalyzing energy use. The outcomes of the tests show that EKC is present in all quantiles excluding the first and second quantile. The economic growth only leads to a rise in environmental pollution during the initial phases of growth; but, once attaining an exact revenue level, this effect of GDP on release rate reverses. The theory behind FD's impact on emissions rising is that increasing FD in emerging nations results in economic consequences. FD supports growth in the economy by helping developing countries' financial industries thrive.

Table 4: Quantile estimation values with reference to the Variables, location and scale.



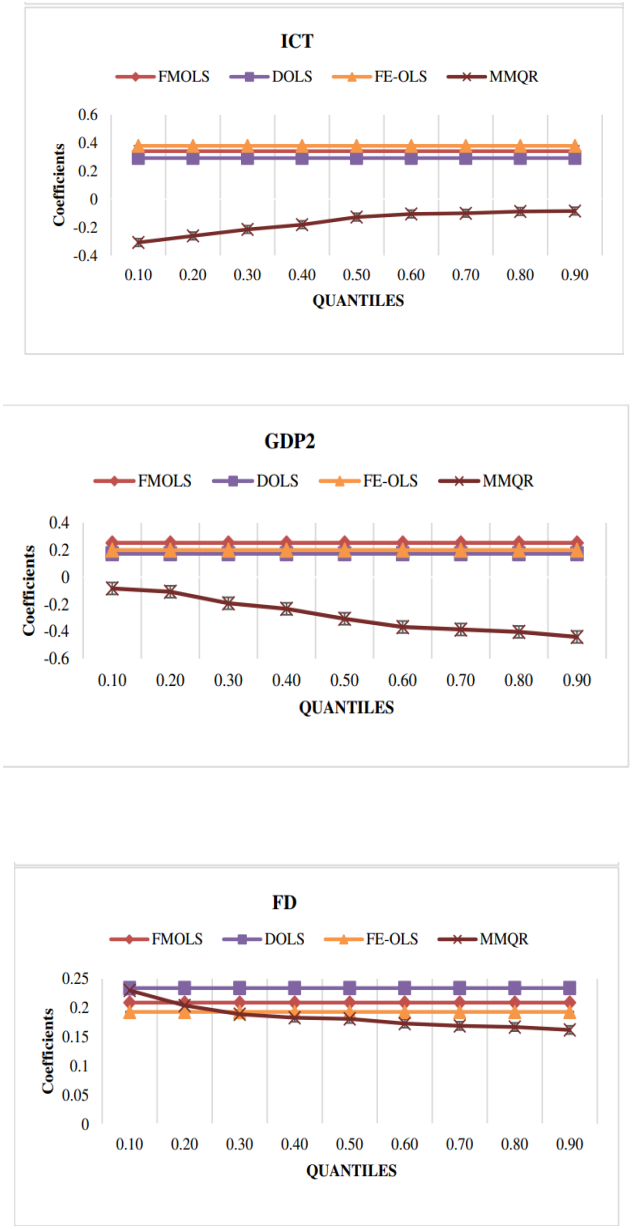


Figure 2: Coefficients in four-panel estimation methods

The impact of Economy and Technology on CO2 is seen in Figure 2 as being lowest at lower CO2 quantiles and gradually increasing as one moves towards higher emissions quantiles. Conversely, the impact of GDP2 and FD on CO2 is greatest at higher quantiles of CO2 and decreases as one proceeds from higher to lower quantiles of emissions. It is obvious through the contrast that the MMQR offers greater clarity among variables at various levels of CO2 emissions, in developing asymmetrical strategies to accommodate various variations in emissions. It indicates that utilizing ICTs for purchasing goods online, getting delivery, conducting video calls, and teleconferences is better to travel, which contributes to a major source of CO2 emissions, and is also less energetic and carbon-intensive.

CONCLUSIONS

Applying the EKC model, this study analyses the connection between ICT and other pertinent growth signs and carbon dioxide emissions in the BRICS countries. It provided a few significant conclusions that could prove helpful for creating that pushing in an approach to policy that targets the countries of the BRICS and focuses on the SDGs. The present research aims to promote this regulatory framework that might serve as an introduction for emerging countries that find it difficult to cope with the problem of rising CO2 emissions. While the BRICS nations' economic development trajectory holds promise for the preservation of the environment, the elements causing this acceleration may have varied impacts on it. The role of ICT actually decreases with rising CO2 emissions, in contrast to the conclusion that financial development also acts as a driver of CO2 emissions. Given that these growth drivers are having a negative externality on the environment, it may be concluded that a reorientation at the policy level is necessary in this instance. Thus, these unwanted externalities ought to be internalized by the proposed policy framework. In spite of this, it's crucial to keep in mind that the economic development of these countries depends on technology that burn fossil fuels. Consequently, any sudden alteration in the energy sources might throw off the overall development trend. As a result, a phased approach must be used by the decision-makers. Both the loan disbursement process and the registration of new firms should take the companies' prospective carbon impact into account. The nation's financial gain will gradually rise with the opening of new firms.

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