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POLICY BRIEF

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What factors are driving CO_2 emissions in southern Africa – and what action should be taken?

Abstract

Global warming and climate change are becoming major concerns for countries all over the world, including Africa. This CEEPA study investigated the factors that are driving the production of carbon dioxide emissions in six African countries. In particular, it looked at whether the relationship between CO_2 emissions and per capita income could be described using an environmental Kuznets curve. The study aimed to provide African policy makers with information that would help them respond to the climate change challenge.

The study's results suggest that in Botswana, Zambia and Zimbabwe the main driving force behind rising carbon emissions is per capita income. However, it found no evidence to show that the link between carbon emissions and per capita income could be modeled using the environmental Kuznets curve. This means that CO_2 emissions from the six African countries covered by the study will not automatically come down as their economies grow. Policy makers should therefore do more to reduce carbon emissions by, for example, switching their countries to a less polluting energy mix.

What link is there between economic development and CO_2 emissions?

A summary of CEEPA Discussion Paper No. X: Determinants Of CO_2 Emissions: Evidence From Southern Africa By Emmanuel Ziramba, Department of Economics, University of Namibia,

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Report Summary

Global warming and climate change are worldwide problems that threaten to increase the long-term surface temperature of the earth. Carbon dioxide (CO_2) is the most important of the multiple environmental pollutants that are causing climate change. While emissions of CO_2 have grown rapidly in most countries in the last few decades, the reasons for this growth have varied from country to country.

The international community has highlighted the need to effectively control CO_2 and other GHG emissions through a number of agreements and protocols. For instance, the UN's Kyoto protocol (which came into force in 2005) states that emissions of GHGs from developed countries should be reduced to at least 5% below 1990 levels by 2008-2012. While EU countries have made a commitment to an 8% reduction of GHG emissions for the same time period. At the end of 2005, another round of environmental meetings took place during a summit in Montreal, Canada, to push for further measures to reduce the emissions of greenhouse gases.

Understanding the factors that drive GHG emissions

In order to deal most effectively with the greenhouse gas challenge, it is vital to understand what factors are driving any growth in GHG emissions (and what factors can act to reduce these emissions). Although a significant amount of research has been done on these determinants, much of this has focused on developed countries in Europe and North America. However, policy makers in Africa are becoming increasingly aware of the need for African countries to respond to the global warming threat (especially as many countries in the continent are at risk of climate-change-induced desertification and falling agricultural outputs).

In order to provide these policy makers with much needed information on which to base future actions, this study set out to investigate the influence of various factors on CO_2 emissions in six southern African countries. The countries were chosen based on the availability of data. They were: Botswana, the Democratic Republic of Congo, Mozambique, South Africa, Zambia and Zimbabwe. In particular, the study focused on whether CO_2 emissions are linked to per capita income in a way that is described by the so-called Environmental Kuznets Curve (EKC). If this is the case, then it would give some hope that economic growth can 'automatically' help to reduce CO_2 emissions.

> **"the main driving force behind carbon emissions is per capita income."**

The Environmental Kuznets Curve (EKC)

The Environmental Kuznets Curve (EKC) describes an inverted U relationship between per capita income and environmental pollution. Its name comes from Simon Kutznets who observed a similar relationship between income and poverty in the 1950s. The EKC relationship implies that environmental pollution increases in the early stages of economic growth, and that it eventually decreases after income exceeds a threshold level. It is the mathematical description of a process of development that leads from a basic agrarian society (that has a limited environmental impact), through a highly polluting industrial phase, and then on to clean economy that delivers sustainable services. There are a number of studies that have confirmed the existence of such an inverted-U relationship for CO_2. These earlier results provided an important motivation for this study.

The study used time-series data for each of the selected countries. Data existed for the different countries over different time periods, which stretched between 1971-2007. The major data source was the World Bank's World Development Indicators CD-ROM (2010). The study analysed time-line data from the individual countries. It also undertook a panel analysis of the determinants of CO_2 emissions across all six nations. This investigated the determinants of carbon dioxide emissions over the period 1981- 2005.

Assessing the factors that influence CO_2 emissions

This data was assessed to see what relationship there was between CO_2 emissions per year (measured in metric tonnes), per capita GDP (measured in US$), and a range of other variables that are thought to influence emissions. The assessment involved the use of the autoregressive distributed lag model (ARDL). This was used to establish both the short- and long-term relationships between carbon dioxide emissions and the chosen variables for each country.

Carbon dioxide emissions included those stemming from the burning of fossil fuels and the manufacture of cement. GDP per capita was calculated by dividing a country's gross domestic product by its mid-year population.

Among the variables considered were foreign trade and the value that the service sector added to GDP (this was measured as a percentage of GDP and was included to assess the potential impact of structural changes on CO_2 emissions). Openness to foreign trade was calculated from the sum of exports and imports of goods and services (measured as a share of gross domestic product). The impact of a range of service industries was considered. These included the wholesale and retail trade (including hotels and restaurants) and transport, along with government, financial, professional and personal services such as education, health care and real estate services.

Although most previous similar studies have included energy consumption as one of the variables that might influence CO_2 emissions, this factor was excluded from this study because it was found to be highly correlated with carbon emissions (the correlation coefficient was as high as 0.99 in some cases).

Income is a major driving force behind carbon emissions

The study found that income had a positive effect on CO_2 emissions in all countries except for Mozambique. When the scope of this effect was assessed it was found that, overall, the main driving force behind carbon emissions is per capita income in three of the countries (Botswana, Zambia and Zimbabwe). These results are consistent with those of previous studies.

It was found that foreign trade has a negative impact on CO_2 emissions in Botswana, South Africa and Zambia. Conversely, it was found that foreign trade has a positive impact on CO_2 emissions in the remaining three countries (although this was only significant in the case of South Africa). Past research has shown that the net effect of trade on pollution could depend on the relative strength of several opposing factors – which explains these variable results.

The degree to which the service sector added to GDP was found to have a negative impact in four of the countries (Mozambique, South Africa, Zambia and Zimbabwe). This effect was found to be significant in the cases of South Africa and Zimbabwe. These results indicate that a growing service sector can reduce pollution-intensive industries and thus CO_2 emissions in these countries.

When short-term impacts were assessed it was found that CO_2 emissions are not determined by short-term fluctuations in per capita GDP. It was also found that, in the short-term, the growth of the service sector, other things being equal, did not reduce CO_2 emissions. The panel results indicated that income, trade openness and the share of GDP contributed by the service sector are all significant determinants of carbon emissions. Further analysis showed that income is non-linearly related to carbon emissions in the panel of countries.

The EKC hypothesis doesn't stand – so action is vital

The EKC hypothesis requires that the estimated long-run coefficients for income and its quadratic term alternate in sign starting with a positive. The study's results indicate that this was only significantly true in two of the countries (Botswana and Zimbabwe). This result provides some support for the EKC hypothesis (that the level of environmental pollution initially increases with income, until it reaches a threshold point, then declines). However, the EKC hypothesis could not be confirmed with graphical representations in both these countries. Based on these results the study concludes that there is no evidence in support of the EKC hypothesis within its sample.

The main policy conclusion from the study's time series results is that the six sample countries need to introduce radical changes in their environmental policies in order to halt the observed increases in CO_2 emissions that are taking place. This is because there is no "automatic" mechanism that will bring down their CO_2 emissions as their economies grow. The results therefore indicate that these African countries should incorporate environmental concerns into their macroeconomic policies more intensely. In other words, policy makers should do a lot more to reduce their countries' carbon emissions by, for example, switching their countries' economies to a less polluting energy mix.

More needs to be done to make Africa's energy mix more sustainable.

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