Beyond the inverted U-shape: Challenging the long-term relationship of the Environmental Kuznets Curve hypothesis

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Executive summary

1. Motivations underlying the research

A substantial amount of greenhouse gas emissions results from the increased use of energy, primarily fossil fuels, as the main driver for production processes and economic growth. Continued emissions of carbon dioxide (CO2) will lead to further surface warming and likely cause irreversible damage to the ecosystem. Following the Environmental Kuznets Curve (EKC) hypothesis, global economic prosperity may reduce CO2 emissions in the long-term: after a certain threshold income level is reached, environmental quality improves over the course of further economic development (Grossman and Krueger, 1991).

The EKC hypothesis however crucially relies on the assumption that initial increases in emissions are only temporary, whereas the subsequent decrease in emissions are considered to be permanent (Dinda, 2004). Consensus regarding the existence or shape of an EKC particularly for pollutants having long-term effects on a global scale such as CO2 emissions have not been reached, although the literature has grown rapidly (Dinda, 2004; Shahbaz and Sinha, 2018).

The estimation of an EKC with a quadratic specification however produces highly biased results in favour of an inverted U-shaped pattern (Lieb, 2003). Ignoring what could happen after the first turning point wrongly leads to the impression that patterns of economic growth are ecologically sustainable (Shahbaz and Sinha, 2019). We thus use a cubic formulation to allow the relationship between income and CO2 emissions to follow other forms than the rather optimistic inverted U-shaped pattern to identify other impacts of income on CO2 emissions by extending the analysis beyond the inverted U.

Against this background, we challenge the long-term relationship of the EKC: our hypothesis is that the improvement in the relationship between income and CO2 emissions is - if at all - only a transitory phenomenon which is unlikely to hold in the long-term. We thus contribute to the relatively scarce cubic EKC literature for CO2 emissions, by analyzing whether the

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Environmental Kuznets Curve does hold in the long-term, or if the improvements are only a transitory phenomenon.

2. A short account of the research performed

We empirically question the long-term relationship of the EKC hypothesis for CO2 emissions using nonstationary panel time series data methods applied to a panel of 69 countries from 1971 to 2014, altogether as well as clustered into high-, middle-, and lower-income groups. To empirically analyze our hypothesis, we utilize a cubic regression specification and account for other relevant CO2 emissions factors than income such as per capita energy consumption and trade-openness. As the EKC hypothesis represents a long-term relationship between environmental impacts and economic growth and to tackle spurious regressions issues, we test for cointegration among the variables. The results of the error correction-based panel cointegration test proposed by Westerlund (2007) supported the existence of a long-term equilibrium relationship in any panel. Within the panel time series framework, we utilize the Pedroni (2001) dynamic group-mean panel DOLS estimation technique to addresses the issue of slope parameter heterogeneity.

We cannot establish an inverted U-shaped relationship but rather find a N-shaped relationship for the global panel which indicates that patterns of economic growth on average are ecologically not sustainable. For our high-income panel our results indicate a N-shaped pattern which strongly suggests that the EKC is not sustainable in the long-term for high-income countries: scale effects tend to exceed composition and technological effects after the second-turning point is reached. Over time, CO2 emissions per capita may decline due to technological and structural changes. However, technological improvements to increase energy and material efficiency may reach an upper limit at which without breakthroughs in research and development further efficiency improvements are exhausted or become economically too expensive and further income growth then leads CO2 emissions per capita to increase again. As a result, the growth component again becomes more pronounced and CO2 emissions will be re-linked as it becomes increasingly difficult to keep up innovation with continuing growth of production (de Bruyn et al., 1998; de Bruyn and Opschoor, 1997). The absence of an EKC for the pollution and income relationship in our lower- and middle-income panel suggests that these countries are still likely to be on the upward sloping section of a possible EKC. Economic growth has not reached income levels high enough at which CO2 emissions per capita decline as economic growth still tends to outweigh environmental concerns (Dinda, 2004).

3. Main conclusions and policy implications of the work

Our empirical results rather support a N-shaped than an inverted U-shaped pattern for the pollution income relationship particularly in the all-income panel. We find no evidence of an inverted U-shaped pattern associated with the EKC hypothesis in any panel. The implementation of stronger and international development cooperation could help to prevent that future economic growth is inevitable accompanied by environmental degradation in early stages of economic development. Thus, countries need to substitute fossil fuels by cleaner inputs as an important measure to reduce carbon dioxide emissions from energy consumption as early as possible. Moreover, as improvements in energy efficiency are often the most readily available means to reduce emissions, all countries should implement policies which support improvements in energy

efficiency within any economic sector. In conclusion, our analysis indicates that simply promoting economic growth is not a panacea to just grow out of pollution related problems in the long-term as hypothesized by the EKC but rather results in a catastrophic roller coaster ride.

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