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Periods of converging carbon dioxide emissions from oil combustion in a pre-Kyoto context

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ABSTRACT

This paper examines convergence of carbon dioxide (CO_2) emissions caused by oil combustion for a panel of 86 countries considering the importance of analyzing sub-periods separately. The investigation also points at the necessity of choosing a restricted global sample, which takes into account, for instance, that Eastern Bloc countries reacted differently to increasing world crude oil prices than the rest of the world. The analysis builds on examining the β-convergence hypothesis in a neoclassical growth model setting with additional control variables such as emissions from combustion of solid fuels. The results reveal evidence in support of unconditional β-convergence of CO_2 emissions intensity due to oil combustion in the restricted sample for the sub-periods 1973–1979 and 1979–1991, while no evidence for convergence was found for the post-1991, pre-Kyoto period. We could not find support for coal substituting for oil, which suggests that the two types of fuels were related to different basic technologies.

1. Introduction

This study is devoted to the investigation of convergence of carbon dioxide (CO_2) emissions due to oil combustion for a panel of countries, taking into account different sub-periods in a pre-Kyoto context.

Reflecting upon the consequences of the oil crises of 1973 and 1979, it is obvious that different groups of countries reacted differently to the crises. As western economies tried to reduce their oil dependency, The Soviet Union (U.S.S.R.) increased oil supply to her allies. This logic definitely ended with the dissolving of the Warsaw Pact in the early 1990s. In this article, we seek to demonstrate the importance of considering the historical context of events when studying carbon convergence: First, econometric analyses should be guided by a historical analysis of structural homogenous periods, aiming at a periodization of the full sample of analysis, recognizing that convergence may have been present during certain sub-periods, but may have been absent during other periods. If two such structurally heterogeneous periods are mixed in one model, the result may be erroneous. Second, a careful selection of the countries that are to be included in an econometric study is necessary. For instance, major oil exporters such as Iran and Saudi Arabia, or countries belonging to the Soviet bloc, with planned economies and bilateral trading schemes following the agreements of the Council for Mutual Economic Assistance (COMECON), should necessarily be investigated separately in terms of their energy-related emissions due to their different economic reactions to oil crises. Third, primary energy sources that give rise to CO_2 emissions (oil, coal or other

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fossil fuels) are related to partly different technologies; today, oil is foremost used in the transportation sector, while coal is primarily used for electricity production and in steel furnaces. Hence, oil-related emissions are analyzed separately in this study.

The study scrutinizes the pre-Kyoto period (i.e. before the Kyoto Protocol entered into force in February 2005). Although the Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change (UNFCCC) and many countries have ratified it, there are several signatories who remain without a national greenhouse gas (GHG) emissions target, or have not made a commitment to reduce their GHG emissions by 2020. Besides, the post-Kyoto period goes in hand with many other national or regional climate policy changes and systems (such as the EU ETS). An additional periodization after 2004 would need to consider not only these policies or systems but also the global financial crisis, where the challenge is to find an appropriate end year not merely motivated by the last year of available data.

This study therefore seeks to explore carbon β-convergence along these lines over the period 1973–2004, with a specific focus on oil-related emissions in a global sample and a restricted sample of oil consuming economies respectively. This focus is one of the main contributions of this paper to the environmental convergence literature since convergence in oil-related emissions has not been addressed frequently. The basic design is to conduct an econometric test of oil convergence over three sub-periods corresponding to major oil crises and energy policy phases, which reflects another novelty of the study. To this aim, the knowledge of the historically relevant context is used for periodization, rather than a statistical one.

The organization of the paper is as follows: Section 1 continues with the theoretical background for carbon convergence followed by a summary of the findings from previous literature. Section 2 describes the data, Section 3 provides the methodology, presents the regression findings and interprets the results for the three sub-periods, and finally, Section 4 concludes.

1.1. Theoretical Background

It is widely known that the hypothesis of income convergence is rooted in the Solow model (Solow, 1956), where countries (or regions) at lower income levels are envisaged to enjoy higher income growth rates than those that are at higher income levels due to the assumption of diminishing marginal returns to capital. Convergence has also been widely discussed in macroeconomic theory and tested via empirical analyses. This literature, which covers both economics and economic history, is too large to be surveyed here, but includes such seminal work as the study by Barro and Sala-i Martin (1992), who test a neoclassical growth model for convergence across 48 U.S. states. They regress the average growth rates over the entire sample (and over various periods between 1840 and 1988) on initial income levels, showing that the whole sample converged in terms of economic growth when sectoral composition and region variables were controlled for.

Environmental convergence research is inspired by previous economic convergence literature and uses similar methodologies to inspect cross-country emissions convergence for various samples and different time spans. The idea stems from the fact that the evolution of income and pollution are both determined simultaneously. This is a consequence of the macroeconomic model suggested by Kriström (2000), in which environmentally harmful pollution and incomes are the outcome of a joint production function, and where society seeks to find the optimal mix of the two, maximizing welfare. This, in turn, is a reasonable assumption since most, if not all, economic activity requires energy use and energy is usually generated via the extraction of natural resources at the expense of various negative environmental effects. This was a fundamental scientific theoretical proposition in Georgescu-Roegen's (1971) seminal work on the entropy law and economic process. In a post-industrial revolution time frame and for England even before that, one effect of this has been the CO_2 emissions arising from the combustion of fossil fuels.[1] Needless to say, the relationship between economic growth and emissions depends on the decisions of households, firms and governments as well as the underlying institutional and policy frameworks. Moreover, the relationship is not independent of the characteristics of what can be described as technological regimes, as well as the social capability of different countries to embrace new technologies (Panayotou, 1993).

1.2. Findings of the Relevant Literature

There is a rich empirical literature devoted to convergence of CO_2 emissions at the global or regional level (e.g., Aldy, 2006; Ezcurra 2007; Strazicich and List 2003; Nguyen Van, 2005; Panopoulou and Pantelidis 2009; Westerlund and Basher, 2008; Camarero et al., 2008; Brock and Taylor 2010; Camarero et al., 2013). Pettersson et al. (2014) undertake a comprehensive review of the literature on convergence of CO_2 emissions among countries. According to the review, empirical research provides evidence for convergence among developed countries (specifically the Organization for Economic Co-operation and Development (OECD)), while relatively persistent gaps (or in some cases, divergence) are explored at the global level. One of the potential reasons for the latter evidence is that "countries globally differ a lot in terms of fossil fuel reserves, fuels which historically have been relatively costly to transport over long distances (e.g., coal)" (Pettersson et al., 2014: 172). The authors attribute varying results for different subsets of countries (such as convergence among OECD countries) to industrial differences, spillover effects and environmental policies. For instance, in a study of the EU countries over the 1971–2006 period, Jobert et al. (2010) detect absolute convergence in per capita emissions as well as convergence

[1] See Warde (2007) for more detail.