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Carbon dioxide emissions and growth of the manufacturing sector: Evidence for China

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ABSTRACT

Reduction of carbon dioxide emissions without negatively affecting the industrial growth is a dilemma for industries in China. On this issue, an empirical study is provided on the relation between carbon dioxide (CO_2) emissions and industrial growth in the Chinese manufacturing sector. The ARDL (autoregressive distributed lag) bounds testing and cointegration analysis are applied in a multivariate framework including energy consumption and price from 1980 to 2012. Results show the existence of a long-run equilibrium relationship between carbon dioxide emissions and industrial growth; indicating that application of measures leading to carbon dioxide reduction may not negatively affect the growth of the manufacturing sector. In the short term, there is no causality running from energy consumption to industrial growth. Additionally, there is causality between energy price and energy consumption. However in the long term, industrial growth may affect energy consumption, which in return may have influence on carbon dioxide emissions; suggesting that there is a reduction potential of energy consumption and CO_2 emissions in the Chinese manufacturing sector without threatening industrial growth. In effect, some policy suggestions are provided for appropriate measures.

1. Introduction

The mitigation of climate change and reduction of Greenhouse gases emitted by human activities has become a challenge in this century. At the top of the list of the threats to the environment are carbon dioxide emissions. The use of energy represents by far the largest source of emissions. It represents about 65% of all gas emissions and its emission rate is expected to increase if no appropriate measures are implemented [1]. China has become a key player in the world economy. The sustained economic growth experienced by the Chinese economy has driven up the energy demand, leading to increase the carbon dioxide emissions. In 2012, the carbon dioxide emissions from China were estimated to be 9208.1 million tons CO_2, representing 26.7% of the total global emissions [2]. Therefore, the success of any global carbon dioxide emissions mitigation project depends considerably on the potential of China to honor its commitment in this regard. Li et al. [3] found that China will need to eliminate about 1651million tons of CO_2 emissions by 2020 in order to achieve the target of reducing CO_2 emissions per unit GDP by 40–45% compared to the level observed in 2005 (even in case of slow economic growth scenario). This figure reflects the enormous task ahead of China to reach this objective. In this regard, some targets have been formulated. Under the Copenhagen Accord in 2009, the government announced pilots projects leading to reduce CO_2 emissions per unit of GDP by 40%–45% in 2020 compared to 2005. Moreover, it was targeted in the Five-year plan (12th FYP, 2011–2015) to reduce the carbon dioxide emissions per unit GDP by 17% in 2015 compared to 2010; to increase the proportion of non-fossil fuel energy consumption by 11.4%; and to decrease the total energy consumption per GDP by 16%. Over the past three decades, while the energy consumption in Chinese industries has been growing, Coal continued to be the principal energy source due to its cheap price and abundance [4]; hence this coal-domination as energy source will not change in the near future. For this reason, CO_2 emissions of China will be rigid for a relatively long time and the realization of emissions reduction targets must therefore be better planned and appropriate actions implemented. The issue becomes challenging considering potential

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consequences on the sustainability of industrial growth. Therefore, the aim of this paper is to examine the relationship between the CO_2 emissions and industrial growth in the Chinese manufacturing sector. Estimated to be 10159.7 billion yuan in 2012, the manufacturing sector's value added grew since 1980 by 12% on annual average. In the meantime, energy consumption increased by 6% annually [5], which had as consequence to increase CO_2 emissions by 5% annually (Fig. 1). In general all over the study period, the value added constantly grew. The energy consumption also increased in order to support the industrial growth. As consequence, the CO_2 emissions also shot up. However according to Fig. 1, there is disruption occurred in years 1993, 1994, 1996 and 1997. During these years, there were important decrease in CO_2 emissions while the value added kept growing. This can be explained by a relative structural stability in manufacturing sector and more energy diversification during that period.

During the last decade, the growth in energy consumption and CO_2 emissions have become more important compared to the trend of industrial growth; meaning that reduction in energy consumption and CO_2 emissions did not or slightly lead to a decrease in industrial growth. Considering this data and the expected sustained growth of the manufacturing sector, there are serious concerns about CO_2 emissions and the necessity to contain and even mitigate it. In an attempt to examine this aspect, it is necessary to obtain answers to some questions:

(i) Is there any relation between CO_2 emissions trend and the growth of the Chinese manufacturing sector? (ii) What are the main factors driving the CO_2 emissions trend? And (iii) what are their degrees of influence? Answers to these questions are important and will be useful in several points by providing information on the aspects to focus on in order to mitigate CO_2 emissions and by helping for the identification of alternative energy conservative measures. Moreover, this paper gives useful orientations for appropriate policies measures to reduce industrial CO_2 emissions without adverse effect on industrial growth.

It is for this purpose that we investigate the causal relationship between industrial growth and carbon dioxide emissions in the Chinese manufacturing sector for the period 1980–2012. We include energy consumption and energy price variables into the framework; which would help to provide important instruments for policy framework since these variables could be affected by or influence changes in carbon emissions and industrial growth. Moreover, this approach overcomes argument on bivariate method which is subjected to omitted variable biasness. The determination of the direction of the causality among the variables is also essential, with key consequences for the energy policy.

Hence, we provide a more robust methodology based on four steps in order to investigate the existence of long run relationship. Firstly, the ARDL (autoregressive distributed lag) method is employed to determine the cointegration relationship among the variables. Once the long run relationship is established, we apply the Johansen cointegration test for robustness evidence to strengthen our findings. Following this, we use Granger causality procedure to determine the direction of the relationship among the variables.

The remainder of this article is as follows: section 2 provides a brief literature review. Section 3 defines the methodology and data sources. Section 4 focuses on the empirical analysis. Section 5 provides the results interpretation and the section 6 summarizes our findings.

2. Literature review

Prior to the analysis of the relationship between CO_2 emissions and industrial growth, it is relevant to review previous research on the subject. There are a lot researches conducted about the relationship among economic growth, carbon dioxide emissions and energy consumption. These researches can be classified into three main tendencies. The first one is axed on the link between economic growth and environmental pollution. According of this tendency, researches analyze the existence of "EKC (environmental Kuznets curve)"; which suggests an inverted *U*-shaped relationship between environmental deterioration and income level. Environmental degradation increases with increasing per capita income during the early stages of economic growth, and then declines with increasing per capita income after a threshold. The first empirical study was conducted by Grossman and Krueger [6], followed by several others [7–9]. Managi and Jena [10] focused on the determinants of environmental productivity and discovered the presence of environmental Kuznets curve type of relationship between environmental productivity and income. Orubu and Omotor [11] reported similar findings for the case of Africa [12]. Investigated the EKC hypothesis with regards to the relationship between carbon emissions, income and energy consumption in 16 EU (European Union) countries. This study did not provide evidence to support the EKC hypothesis in EU between 1990 and 2008 periods. Song et al. [13] found a long-run cointegrating relationship between per capita emissions of pollutants and per capita GDP as well as the existence of inverse *U*-shaped. In the same order, Esteve and Tamarit [14] found the existence of Environmental Kuznets Curve for the Spanish case. However, analysis of such nature have been criticized [15].

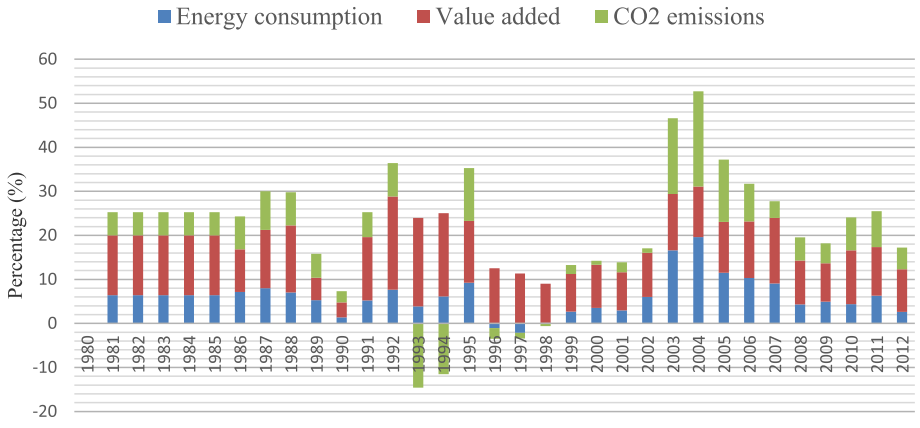

Fig. 1. Percentage change of CO_2 emissions, energy consumption and value added in the Chinese manufacturing industry.