Impact of economic recession on carbon emissions:
A cross-national empirical analysis

In the past decades, endeavors to mitigate greenhouse gas (GHG) emission have been implemented among various countries and regions, such as European Union Emission Trading Scheme (EU ETS), which is regard as the most successful carbon emission reduction policy. Yet, evaluations of this program are far from unanimous, to what extent these schemes are able to mitigate carbon emission is still in debate. One argument propose that economic recession is an important driver of carbon emission reduction. For instance, Declercq, Delarue & D`haeseleer (2014) investigate the impact of economic recession on CO_2 emissions in the European power sector from 2008 to 2009, suggest that the lower demand for electricity during recession periods is the most important factor for carbon emission mitigation, compare to lower CO_2 price and lower fuel piece.

Corresponding to this issue, we comprehensively investigate the impact of economic recession on carbon emissions among 157 economies all around the world, during the years 1960-2013. For the variables employed, we use "de-carbonization" as dependent variable[1]. Economic recession[2], together with other major factors influencing carbon emissions, e.g. de-forestation, foreign direct investment (FDI), and government debt, are illustrated and tested in this study. urbanization (percentage of population living in urban area), exports and imports are set as control variables, according to IPAT model. Further, we employ GDP per capita as intermediate variable to detect whether shrinking income induced by economic recession is a major driver to realize de-carbonization, this mechanism can be illustrated as "economic recession – lower income – de-carbonization". In addition, we detect the correlations between economic recession and innovation, economic recession and environmental policies (renewable investment, carbon tax, etc). Main findings are listed below:

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[1] We quantify "de-carbonization" as a continuous variable from -n to + n, where n is % reduction in carbon emissions from the year before. For example, our variable will be -5 if carbon emissions increased 5% the last year.

[2] Economic recession is also quantified as a continuous variable, which is able to illustrate the severity of recession.

The first, China, U.S., Japan and India are the largest emitters around the world. The U.S. and Japan hold higher GDP per capita, while China and India still in low income level, this imply that China and India, the two largest developing economies with huge population, will keep increasing their carbon emissions in the foreseeable future (see Fig. 1). Further, we plot the changes of world average carbon emissions and world average GDP growth rate from 1960 to 2013 (see Fig. 2). It is not difficult to find that, in general, carbon emissions rapidly increased in the past decades, and only stagnated or slightly decreased during worldwide economic crises, such as The Oil Crisis (1973-1975), Asian Financial Crisis (1997-1999), and Sun-prime Crisis (2007-2009). This finding pass on a message to us: absolute de-carbonization may be significantly correlated to economic recession, especially crises (severe recession).

The second, we use advanced method to work out the mean values of de-carbonization, de-forestation, FDI and debt respectively, three years before and three years after the recession. Results showing that, generally speaking, de-carbonization begins one year before the recession, and keeps de-carbonized until three years after the recession, this means recession indeed reduced the carbon emissions. However, what is worth noting, all the mean values are negative, implying that most of the recessions are only relatively de-carbonized, absolute de-carbonization are still rarely seen. De-forestation does not showing clear relationship before or after the recession, similar situations apply to FDI and government debt.

Lastly, empirical regression results showing that, de-forestation, FDI and debt have no significant relationship to de-carbonization, while economic recession manifests significant correlations at 1% level in all scenarios. Further, we employ interaction terms to detect correlations between de-carbonization and recession for developing and developed economies respectively, results suggesting that developed economies showing no significant relationship any more, although still positively correlated; correlations for developing counterparts present significant but in 5% level. At last, we add GDP per capita as an explanatory variable, recession variable turn to

10%, while GDP per capita showing 10% significance level either, suggesting that reduced income level during recession plays an essential role for de-carbonization.

Four improvements are highlighted in our analysis: first and foremost, changes of de-carbonization, de-forestation, FDI and government debt during recession periods are illustrated intuitively; secondly, we specified that economic recession is the most essential determinates to de-carbonization, de-forestation, FDI and government debt are less correlated to carbon emission; thirdly, the correlations for developing economies are significant than developed counterparts; lastly, we find that reduced income caused by recession is a major factor to de-carbonization.
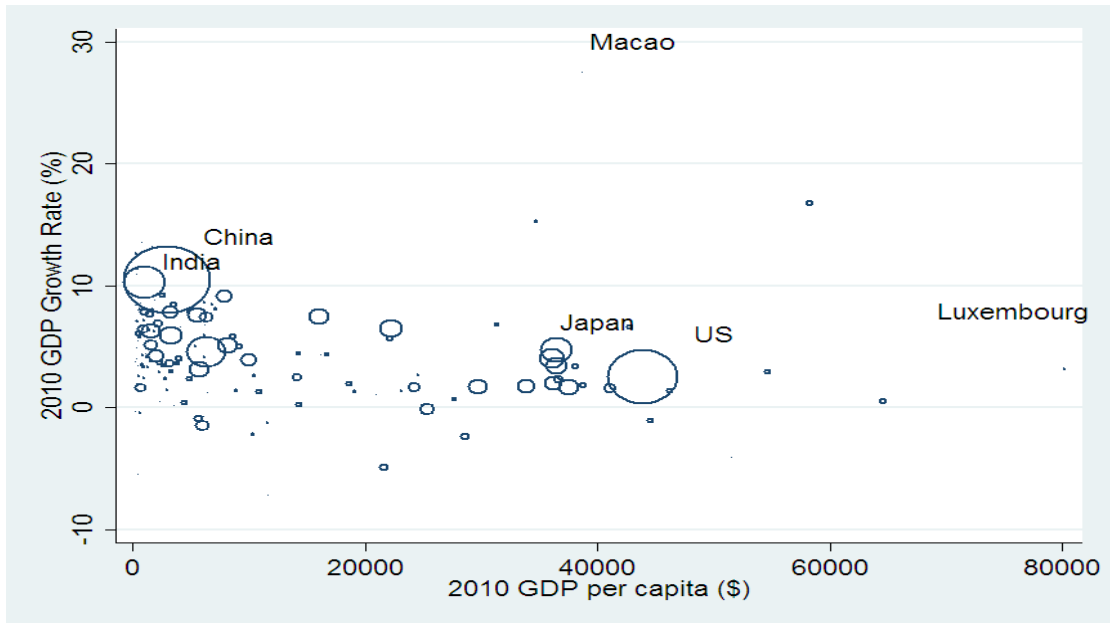
Fig. 1 carbon emissions under different GDP growth rate and GDP per capita

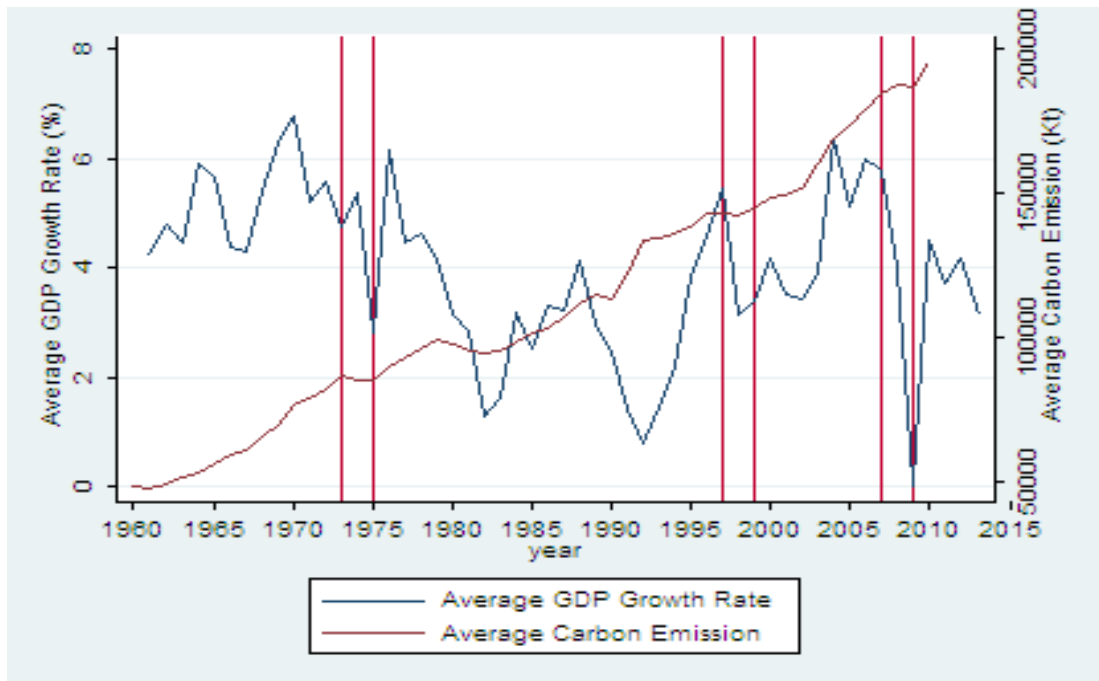of the 157 economies worldwide, 2010.

Fig. 2 World average GDP growth rate and carbon emission during 1960 to 2013

Notes: the vertical red lines denote the Oil Crisis (1973-1975), Asian Financial Crisis (1997-1999),

and Sun-prime Crisis (2007-2009), respectively.

Reference

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Summary

Previous researches on economic recession mainly focus on economics and finances, fewer studies discuss the impact of economic recession on carbon emissions. In this study, we employ panel regression and other advanced methods, to comprehensively investigate the impact of economic recession on carbon emissions among 157 economies all around the world, during the years 1960-2013. Findings show that: the first, carbon emissions rapidly increased in the past decades, and only stagnated or slightly decreased during worldwide economic crises; the second, generally speaking, de-carbonization begins one year before the recession, and keeps de-carbonized until three years after the recession. However, most of the recessions are only relatively de-carbonized, absolute de-carbonization are rarely seen; the third, economic recession is the most essential determinates to de-carbonization, de-forestation, FDI and government debt have no significant correlations to carbon emission; lastly, the correlations for developing economies are significant than developed counterparts, and the reduced income caused by recession is a major factor to de-carbonization. We contribute to a further understanding of the impact of economic recession on carbon emissions under various quantitative approaches.