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Carbon emission targets and decoupling indicators

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ABSTRACT

Carbon intensity targets are part of the emission reduction metrics used in some of Copenhagen pledges and of Intended Nationally Determined Contributions. One of the alleged features of such target format is to secure a reduction in emissions' intensity in order to decouple greenhouse gases generation from economic activity. This article compares the decoupling indicators most commonly used in the literature and shows that, there are more cases to analyze decoupling than those usually considered and that sometimes there is agreement but there can also be disagreement among indicators. Decoupling is not a goal in itself, diminishing emissions is. In that sense, it becomes clear here that strong delinking of emissions from GDP is better than weak decoupling in growing economies (because emissions' intensity decreases in both cases but emissions only diminish in the former), but this ranking does not hold in recessive economies. When the economy is in recession, weak negative decoupling over scores strong negative decoupling since, only in the former, emissions decrease. Nevertheless, the best possible state in an economy in retraction is recessive decoupling, that is "green degrowth" (emissions, GDP and emissions' intensity all decrease). In the existing literature, decoupling indicators have been employed to analyze countries, regions, cities, or sectors with stable growth and some of the decoupling degrees were detected. Here, Argentina is used for illustration purposes since it has the advantage to be the first nation to design a GDP related carbon emissions' target and be at the same time a very unstable country. The latter characteristic allows finding almost all cases of decoupling when considering emissions from 1990 to 2012.

1. Introduction

The international community agrees that, in order to avoid massive damages due to climate change, the average increase of global temperature should be kept at least below 2 degree Celsius by the end of the century (with respect to pre-industrial levels). Several research groups have analyzed the gap between the emissions levels needed to achieve that goal and the Parties' climate policies (for example, den Elzen and Höhne, 2008; UNEP, 2010). Those analyses suggest that the gap is substantial; closing it will require emissions reductions of over 45–70% by 2050 compared to 2010 (Edenhofer et al., 2014).

There is still no new agreement on precise emission-reduction targets for each country, and this issue will be part of the discussion in the coming Conferences of the Parties (COPs) of the United Nations Framework Convention on Climate Change (UNFCCC). What is well-known is that emissions can be reduced using different metrics. Kyoto targets were designed as absolute reduction caps with respect to baselines in the past. Then, Copenhagen-Accord pledges were of four types: fixed reductions with respect to the past; absolute reductions with respect to the future (business as usual – BAU) emissions; carbon neutrality objectives (i.e., zero net emissions); and intensity caps with baselines in the past. Intensity caps, contrary to fixed caps, do not set a country's allowable emissions level, but determine its amount as a linear function of Gross Domestic Product (GDP). Hence, what they fix is carbon intensity: Emissions/GDP. Finally, countries agreed at COP 19 in Warsaw to prepare "Intended Nationally Determined Contributions" (INDCs). Most countries have by now submitted contributions of mainly three types[1]: fixed reductions with respect to the past; absolute reductions with respect to the (future) BAU emissions; and intensity caps with baselines in the past.

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[1] See in that respect the official site continuously updated: http://unfccc.int/focus/indc_portal/items/8766.php.

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Both the Copenhagen pledges and the INDCs include GDP related targets. More precisely, two countries submitted linearly indexed pledges to the Copenhagen Accord: China, to reduce its CO_2 emissions by 40–45% per unit of GDP by 2020 compared with 2005; and India, to reduce CO_2 emissions by 20–25% between 2005 and 2020. A few more countries propose intensity metrics for their INDCs: China and India but also others as Chile, Uruguay, Singapore, and Tunisia.

The idea behind setting a target on carbon intensity is to guarantee "emissions' decoupling" (Kim and Baumert, 2002). There are several definitions of decoupling. One of the first was the Organization for Economic Cooperation and Development one, which states that it refers to breaking the link between "environmental bads" and "economic goods." (OECD, 2002). Similarly, UNEP (2011) reports that "Decoupling at its simplest is reducing the amount of resources such as water or fossil fuels used to produce economic growth and delinking economic development from environmental deterioration". In both definitions, decoupling is thought for a growing economy.

Together with its "word" definition, decoupling began to be measured by quantitative indicators. To date, three of them are the most employed. One is the decoupling factor introduced in OECD (2002), which we name D_o, and is grounded on the rate of growth of emissions intensity. The second is the indicator introduced in Tapio (2005) that we denote D_ε since it is an emissions-to-economic activity elasticity. The third measure of decoupling was introduced by Lu et al. (2011), and we refer to it as D_t because its formula includes, in addition to GDP growth, the emissions' intensity decreasing rate. As a result of their measurements, Tapio (2005) and Lu et al. (2011) acknowledge that there are different degrees of decoupling. All of them imply reductions in emissions' intensity when the economy is growing, but only some (absolute or strong decoupling) provide the reduction of emissions needed to mitigate climate change. Decoupling, even in expansive economies, is not virtuous per se if it is assessed together with the objective of reducing greenhouse gases.

The analysis of decoupling has been used in several studies on the link between energy, environment and economy. Separating emission from GDP requires changes to induce green behavior by individuals and firms. For that reason, when the government designs policies toward meeting a carbon target it has to take into consideration what are the determinants of emissions[2] as well as the so-called "rebound effect". This also called "take-back effect" is the reduction in expected gains from measures that increase the efficiency of a natural resource use, because of behavioral changes that may offset it (the term was coined by Saunders, 1992 and a detailed definition is provided by Sorrell and Dimitropoulos, 2008). For instance, improvements in energy efficiency make energy bills cheaper, and therefore may encourage an increase in consumption that partially offsets the energy savings that would otherwise be achieved. There are several empirical estimations of the rebound effect. For example, Jin (2007) calculates a considerable rebound effect for urban residential electricity use for the South Korea energy efficiency policy. More recently, Wang et al. (2014b), also for urban residential electricity, finds a high take-back effect in 30 provinces of China. Firms, as individuals, react to government policies or other stakeholders' pressure in different ways (see for example, Zhang and Wang, 2014 for the determinants of inter-firm collaboration in carbon emission reduction projects within energy intensive industrial chains or Zhang et al., 2015 for the role played by senior managers environmental concerns on firm's energy practices in a region of China).

The three decoupling indicators mentioned above have been applied to analyze the situation of different sectors, cities, regions and nations. Some of those studies refer to specific single pollutants (typically CO_2) and others consider several metrics for environmental pressure. Lu et al. (2007) calculate D_o in Germany, Taiwan, South Korea and Japan on a yearly base between 1990 and 2003, and find coupling between environmental pressure (transportation CO_2 emissions and energy demand) and GDP except for several years in the first two countries. Freitas and Kaneko (2011), using the same indicator, examine the case of Brazil from 1980 to 2009 and find there was substantial decoupling between economic activity and CO_2 emissions from energy consumption at the end of the period analyzed. Conrad and Cassar (2014) also calculate the OECD indicator for several endpoints in the small island of Malta and finds relative decoupling for greenhouse gases from 1995 to 2011. Following the work of Tapio (2005), that introduced an alternative (D_ε) decoupling indicator, Ren and Hu (2012) find different degrees of decoupling for the Chinese nonferrous metals industry along the 1996–2008 period. Zhang and Wang (2013) calculate (D_ε) per year for CO_2 emissions of the whole industry and primary, secondary and tertiary industries in a province of China (Jiangsu) from 1995 to 2009. A similar analysis is done by Wang and Yang (2015) for carbon emissions in the Beijing–Tianjin–Hebei economic band. Wang et al. (2013) using all three decoupling indicators mentioned above (D_o, D_ε and D_t) for materials use, energy use and SO_2 in China, Russia, Japan and the United States during the 2000–2007 period, conclude that decoupling was higher in the two OECD nations than in the two BRIC countries because of their different development stages.

The objectives and main innovations of this article are threefold. First, it makes an easy to understand comparison of the three most commonly used decoupling indicators. As a result of that, it shows that there are more decoupling situations than usually accounted for in most of the literature (those related to stagnated economies) and that decoupling indicators are not always in agreement. Second, it draws attention to the fact that it is important to consider the implications of the different degrees of decoupling in the context of declining or stagnant GDP, not just in economies in expansion. Based on that, it highlights that strong decoupling is always better than relative decoupling and non-decoupling with respect to the change in environmental pressure only for growing economies, but not for declining ones. In the latter case, the ranking in terms of desirable decoupling degrees varies. When the economy is in recession, the best possible outcome is "green degrowth" ("recessive decoupling", and not strong or weak negative decoupling, since they both imply higher emissions' intensity). Third, this manuscript illustrates the different cases of decoupling signaled by each of the indicators using the case of Argentina. Argentina is especially relevant since it was the first country to present an emission target linked to economic activity in climate negotiations (Argentine Republic, 1999; Barros and Conte Grand, 2002). And, also because it is a rather unstable country with highly positive and negative economic growth rates, which allows finding more diverse cases of decoupling than in continuously growing economies.

This article is organized as follows. In Section 2 we compare conceptually (and mathematically) the different values the decoupling indicators can take, considering not only the case of economies in expansion but also the possibility of economies in recession or stagnation. We evaluate those cases for which there is (partial or complete) agreement or disagreement among the degrees of coupling/decoupling for the three indicators. Then, in Section 3, we discuss the situation of Argentina in terms of each of the one coupling/decoupling cases. Section 4 concludes.

[2] In particular, there is a fruitful field of research that analyzes the ways to attain energy related emissions' decline by energy efficiency measures, structural economic changes or other factors (see, for example, Blesl et al. (2007) for Germany and Zhang (2003) and Wang et al. (2012a,b, 2014a, 2015) for China).