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Co-control of CO_2 emissions and local pollutants in China: the perspective of adjusting final use behaviors

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ABSTRACT

China faces multiple pressures from both global climate change and local pollution. Given that China is now taking economic growth and the improvement of people's living standards as its primary goal, it is necessary to control a variety of environmental problems synergistically to minimize adverse socio-economic impacts. Using an input–output model, this study aims to identify the important behaviors that simultaneously lead to various environmental discharges among the troika of China's economic development (consumption, investment, and exports). The results show that behaviors that have an obvious driving force behind multiple environmental discharges exist in all three final use components. Household consumption of health care, residential services and real estate; investments in construction, transport equipment, and special purpose machinery and exports of electrical machinery/equipment and electronic equipment had obvious driving effects on most of the environmental discharges examined, totally covering 25.62% (COD (chemical oxygen demand))-54.91% (soot and dust) of the corresponding environmental discharges. Household consumption of electricity and heating and investments in general purpose machinery are behaviors with obvious driving effects on CO_2 emissions, air pollutants and solid waste. Household consumption of agricultural byproducts, other processed foods, wine, drinks and refined tea, textile wearing and apparel; exports of textiles, textile wearing and apparel, raw chemical materials and chemical products had obvious driving effects on water pollutants. The characteristics of these behaviors and their roles in social and economic development are then discussed. Based on the discussions, potential ways to utilize the identified behaviors are recommended: household consumption of electricity, heating, food, wine, drinks and refined tea, textile wearing and apparel should be guided toward a more conservation-oriented approach; the structure of investments in transport equipment, special and general purpose machinery, and exports of electrical machinery/equipment, textiles, textile wearing and apparel, raw chemical materials and chemical products should be adjusted toward more high-end products; the discharge intensities of the supply chain of health care, residential services, real estate and electronic equipment should be further lowered; the investment in construction should be planned more rationally, while the unnecessary waste of high-discharge-intensive construction materials should be avoided.

1. Introduction

Currently, China is facing multiple severe challenges related to the environment. On one hand, as the largest emitter of CO_2 in the world, China now faces enormous international pressure in the post-Kyoto era. On the other hand, local environmental problems such as air pollution, water pollution and solid waste pollution remain outstanding: the air quality of many cities continues to deteriorate; the water quality of the main freshwater systems remains unsatisfactory; and municipal household waste, industrial waste and medical waste still do not receive proper disposal. These issues have had serious impacts on people's daily lives and the healthy development of the society.

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To maintain benign economic growth, continue to improve people's livelihood and achieve sustainable development, the government of China has mentioned corresponding objectives for controlling various environmental problems. For example, during the current "12th Five-Year Plan" period (i.e., 2011–2015), the government aimed to cut carbon dioxide (CO_2) emissions per unit of GDP by 17%, to reduce sulfur dioxide (SO_2) and chemical oxygen demand (COD) by 8%, nitrogen oxide (NO_X) emissions and ammonia nitrogen discharges by 10%, and to reach the comprehensive utilization rate of industrial solid waste of 72%. Corresponding policies have been implemented to achieve these goals, such as the establishment of a carbon trading market, the installation of desulfurization and denitrification equipment in factories and increasing treatment plants of wastewater and solid waste. However, the reduction effects of these measures have not been very successful, according to the latest China Statistical Yearbook on Environment 2015 (Ministry of Environmental Protection, National Bureau of Statistics PR China, 2015). Compared to the situation in 2010, although SO_2 emissions have decreased by 9.64%, the emissions of CO_2, NOx, COD, ammonia nitrogen, soot and dust have increased by 14.86%, 12.18%, 85.3%, 98.3%, 36.23%, respectively, in 2014. Moreover, the comprehensive utilization rate of industrial solid waste declined to 62.1% in 2014 (67.14% in 2010). Therefore, much more needs to be done to accomplish these environmental objectives, which has introduced a new problem: given that the generating mechanisms or driving sources of different environmental problems may have a certain degree of similarity,[1] if the solutions to each problem are considered in isolation, the government may act excessively, leading to additional socio-economic losses.[2] Considering that China should still make economic growth and the improvement of people's living standards its primary goals, it is necessary to examine various environmental problems from the synergy perspective.

The synergistic control of different environmental problems has received increasing attention around the world. For example, The Intergovernmental Panel on Climate Change (IPCC) put forward the theory of co-benefits in its 2001 Third Assessment Report (IPCC, 2001), claiming that most policies about greenhouse gas mitigation also have other, at least equally important goals, including the reduction of air pollution.

To date, many studies have been conducted on the topic of synergistically controlling greenhouse gases and local pollutants. Most of these studies have focused on the co-benefits between greenhouse gases and air pollutants, and they have generally supported the existence of potential synergistic effects. On one hand, related climate policies, such as a carbon tax (Rypdal et al., 2007; Shakya et al., 2012), or technological progress measures, such as the improvement of energy efficiency (Creutzig and He, 2009; Williams, 2007), could lead to the reduction of air pollutants while reducing greenhouse gas emissions. For example, Shakya et al. (2012) analyzed the co-benefits of introducing a carbon tax in Nepal over the 2005–2050 period. Their results showed that when the carbon tax gradually rises from US\$ 13/tCO_2e in 2015 to US\$ 200/tCO_2e by 2050 and the accumulated reduction of greenhouse gases reaches 83.9 million tons of CO_2e, the emissions of SO_2, NO_X, and non-methane volatile organic compounds (NMVOCs) will also decrease by 12%, 7% and 1%, respectively. Williams (2007) evaluated the air quality in the UK around 2050, given the assumption that significant changes will be made to energy and transport technologies in order to realize a 60% reduction in carbon emissions by 2050 on a 1990 baseline; the authors found the possibility of significant synergies and co-benefits. However, several policies controlling air pollutants could also result in the reduction of greenhouse gas emissions (Gielen et al., 2001; Li and Crawford-Brown, 2011; Morgenstern et al., 2004; Nam et al., 2013; Xu and Masui, 2009). For example, Gielen et al. (2001) analyzed the impact of a significant reduction in local air pollution on GHG emissions in Shanghai for the 1995–2020 period. They found that, due to energy and local air pollution reduction policies, CO_2 emission discharges would drop by up to 24% in the year 2020 compared to the levels of the baseline scenario. Morgenstern et al. (2004) studied the ancillary benefits of reducing SO_2 emissions from small, coal-burning boilers in Taiyuan and found that this policy would also lead to a significant reduction in carbon emissions (on the order of 50%–95%).

In general, there are two kinds of methods for achieving synergies: technical measures and behavior adjustment. The use of technical measures is a more fundamental and direct solution, so most existing studies have focused on this aspect to discuss issues such as synergistic reduction effects (Mao et al., 2011), the identification of various pollutant sources and corresponding solutions (Valipour et al., 2012, 2013a, 2013b), the cost effectiveness of a certain technology (Hasanbeigi A et al., 2013; Yang et al., 2013) and the comparison of multiple technical means (Chae, 2010). However, the use of technical measures has limitations, such as high research and development costs and long periods necessary for large-scale application. Moreover, because technical measures are based primarily on generation mechanisms, they can usually control only the same form of pollutant. For example, it is difficult to control water pollution and carbon emissions at the same time using a particular technology. This fact could also explain why most existing related studies, which have targeted mainly technical measures and process monitoring, have focused on co-controlling greenhouse gases and air pollutants. Regarding the drawbacks of technical measures and the severity of various problems China is currently facing, this study aims to explore the synergistic control of different environmental problems from another perspective: behavior adjustment. Behavior adjustment could be performed on intermediate use activities, e.g., to reduce the waste of input materials during the production process, or it can be performed on final use activities. Final use refers to consumption, investment, and exports, which are the troika driving economic development. Any kind of change from final use behaviors will ripple throughout the economic system, thus leading to a corresponding change in environmental discharges. Therefore, beginning with final use behaviors, a control effect in which a slight move in one part affects the situation as a whole can be achieved. In reality, behavior adjustment is an important aspect that has received attention from the Chinese government. For instance, several behavior adjustments have been introduced in the "12th Five-Year Plan" and "13th Five-Year Plan", such as green consumption, low-carbon lifestyles, a green supply chain and the development of a recycling economy. Moreover, researchers have also already focused on the environmental impact of adjusting final use behaviors in recent years and have produced a series of studies. For example, Jiang et al.

[1] For example, coal combustion will produce both CO_2 and SO_2 emissions, driving a car will lead to NO_X and SO_2 emissions simultaneously, and eating out will generate waste gas and wastewater discharges at the same time.

[2] For example, adopting a policy on coal when considering the goal of reducing carbon intensity by 17% may also cut some SO_2 emissions. Accordingly, adopting another policy on coal when considering the 8% SO_2 emission reduction target can also reduce some CO_2 emissions simultaneously. Without considering this synergistic effect and still designing the policies according to their own environmental objectives separately, the implementation of the two policies may lead to reduction effects greater than 17% (for carbon intensity) and 8% (for SO_2 emissions); correspondingly, it will have a greater impact on the economic system.