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Distributional effects of a carbon tax on Chinese households: A case of Shanghai

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HIGHLIGHTS

- The direct distributional effect of carbon tax presents a weak progressivity.
- The indirect distributional effect of carbon tax is significantly regressive.
- The comprehensive distributional effect of carbon tax is regressive.
- The Suits index of carbon tax is −0.078.
- Imposing carbon tax on fossil fuels can intensify income inequality.

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ABSTRACT

As an effective policy instrument to reduce CO_2 emissions, the effects of a carbon tax on distribution have been the critical factor in determining whether a carbon tax will be acceptable in China. Taking Shanghai as an example, which is the economic center and front-runner of China, this paper estimates the distributional effect of a carbon tax on households in various income groups by using the input–output model and the Suits index. The results indicate that the comprehensive distributional effect of the carbon tax is regressive. The expenditure of the low-income group caused by the carbon tax accounts for 0.853% of the total expenditure, while that of the high-income group 0.712%. The direct distributional effect presents a weak progressivity, while the indirect one is significantly regressive, and the latter is much larger than the former. Moreover, the Suits index of the carbon tax is −0.078, implying that the carbon tax burden on the low-income group is the highest and thus that a carbon tax can intensify income inequality. Therefore, when introducing a carbon tax, some rational associated redistribution or compensation measures, such as purposive transfer payments, should be implemented to restrict or even eliminate the regressivity of the carbon tax.

1. Introduction

As a major issue of human survival and development, global climate warming has paid extensive attention all over the world. Among the various climate-change mitigation policies, the carbon tax is extensively advocated since it is regarded as the lowest cost emission-reduction measure (Baranzini et al., 2000). As an environmental tax imposed on CO_2 emissions, the carbon tax can reduce CO_2 emissions and thus mitigate climate warming by increasing tax burden. Theoretically, the essential role of a carbon tax is to correct distorted price signals and optimize the resource allocation by internalizing the environmental externality caused by anthropogenic CO_2 emissions. Therefore, the carbon tax is considered as one of the most market-efficient economic measures in reducing CO_2 emissions. Supporters of the carbon tax argue that it has three main advantages. First, a carbon tax can enhance the competitive power of renewable energy in cost and thus promote the utilization of renewable energy. Second, the revenue from a carbon tax can be used to subsidize environmental protection project and energy-saving and emission-reducing

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technology. Finally, compared with carbon emissions trading, a carbon tax has lower administrative cost, more convenient implementation process, and more predictable effects.

A carbon tax has been carried out in some countries and has achieved some desired results. However, until now, there are only a few developed countries actually imposing carbon taxes, such as Finland, Sweden, Denmark, Norway, Netherlands, and Italy. Most countries are cautious about the carbon tax considering that it may produce some negative impacts on national economy by affecting energy price and supply–demand relationship, increasing enterprises' costs, and generating the regressive effect of taxation. Discussions on mechanisms and channels of a carbon tax affecting national economy have been academic focus issue as well as the crucial basis for governments to determine whether to levy a carbon tax. Among various potential impacts of a carbon tax on economy, the influential direction and degree of a carbon tax on distribution are the critical factor in determining whether a carbon tax will be accepted by the public. Hence, it is also a key issue focused on by both governments and academic circles.

Related studies mainly focus on whether a carbon tax will become a regressive tax or not. Whereas, the consensus on this issue is not reached since different conclusions are drawn by using different samples. Empirical evidences from most developed countries indicate that a carbon tax has a regressive effect on distribution (Poterba, 1991; Jacobsen et al., 2003; Kerkhof et al., 2008; Shammin and Bullard, 2009), while some researchers argue that the distributional effect of a carbon tax is proportional or progressive (Symons et al., 2000; Tiezzi, 2005; Dissou and Siddiqui, 2014). Bureau (2011) found that a carbon tax was regressive before revenue recycling. However, Gonzalez (2012) argued that carbon taxes were not necessarily regressive and whether the way revenue was recycled became a major determinant of how the carbon tax costs were distributed. Most existing studies focus on developed countries and there are fewer studies on developing countries. In developing countries, many factors, such as market forces, price regulation, and import restriction, are likely to generate the distributional effect of environmental policy. The results of Brenner et al. (2007) and Yusuf and Resosudarmo (2007) on China and Indonesia, respectively, indicate that a carbon tax has the progressive impact on distribution.

In 2009, the Chinese government announced its emission–reduction target that CO_2 emissions per unit of GDP would be reduced by 40–45% in 2020 than 2005 level. As a part of this target, China's 12th “Five-Year Plan” explicitly proposed an obligatory indicator that CO_2 emissions per unit of GDP should decline by 17% compared with 2010 level. As an effective policy instrument to reduce CO_2 emissions, the pleas to implement a carbon tax are becoming louder in China, but the understanding of the Chinese government in the potential effects of a carbon tax is not clear, especially in the distributional effect of the carbon tax. As a developing great power characterized by obvious imbalance among regions in natural resource endowment and economic development, the distributional effect of a carbon tax is particularly complex in China. The issue has become one of the vital references in determining whether to implement a carbon tax in China. Hence, the distributional effect of the carbon tax should be paid more attention to.

In recent years, although studies on China's economic effect of a carbon tax have become plentiful, most existing literature focus on the impact of a carbon tax on the macro-economy or the competitive power of various industries, while the potential effect of a carbon tax on distribution is paid little attention to. Based on the CGE model, Cao (2009) carried out a comparative analysis on transfer payment effects of different allocation modes of the carbon tax revenue in various proportional taxation scenarios, but did not directly discuss the distribution effect of a carbon tax. Su et al. (2009) analyzed the effects of a carbon tax on China's macro-economy, industrial development, and income distribution in various scenarios of tax rate. However, Su et al. (2009) focused on the effect of a carbon tax on the income inequality of urban and rural dwellers and did not analyze the influential mechanism of the carbon tax on distribution.

In view of limitations above, taking Shanghai as an example, which is an international metropolis and China's economic center and whose economic growth and energy consumption are all on the top in China, this paper estimates the distributional effect of a carbon tax on different income groups and discusses the influential mechanism and channels by using the input–output model to provide some theoretical basis and decision-making reference for the implementation of a carbon tax in China.

As the economic center and front-runner of China, Shanghai is expected to play a leading role in climate change mitigation. With the rapid development, the dependence of Shanghai's economy on energy consumption is increasing. According to *Shanghai Statistical Yearbook*, the total energy consumption in Shanghai has increased from 394.67 million tons of coal equivalent (tce) in 1993 to 1292.61 million tce in 2011, with a average annual growth rate of over 10%. Moreover, with the deepening of energy dependence, Shanghai's CO_2 emissions also present an increasing trend. The total CO_2 emissions from production sectors in Shanghai have increased from 525.02 million tons in 1993 to 1292.61 in 2011, with an average annual growth rate of above 8% (Yang and Shao, 2013). Obviously, Shanghai is encountering the great pressure to realize the target of energy saving and emission reduction (Shao et al., 2011). Therefore, Shanghai is a representative sample in China, and the study on Shanghai can attain some necessary decision-making references to the policy design of a carbon tax in China.

The remainder of the paper is structured as follows. Section 2 addresses the fossil energy consumption of households in various income groups in Shanghai. Section 3 estimates direct and indirect effects of a carbon tax on various income groups. In Section 4, the progressivity of a carbon tax is measured and discussed. Conclusions and policy implications are provided in Section 5.

2. Energy consumption in various income groups

As reported in *Shanghai Statistical Yearbook*, in 2010, the primary energy consumption in Shanghai reached 111.61 million tce, in which coal, oil, and natural gas consumptions were 58.76 million tons, 32.98 million tons, and 4.50 billion cubic meters, respectively. As the main source of CO_2 emissions, the share of fossil fuels in the total primary energy consumption is about 85% in Shanghai. According to the Word Bank Report, above 70% of the total CO_2 emissions are from fossil fuels in the world. Moreover, it is a consensus that imposing the carbon tax upstream is more effective than downstream. On one hand, it is more practicable to impose on fossil fuels than on CO_2 emissions per se. On the other hand, the administrative costs of a carbon tax could be lower through its upstream implementation (Metcalf, 2009). Hence, like some countries where a carbon tax has been imposed (e.g., Sweden, Norway, Denmark), we treat fossil fuels as the carbon tax base.

In addition, it is necessary to classify the households to discuss the distributional effect of a carbon tax. Similar to most related studies, we employ the classification by income levels of households. According to the recent classification standard of the National Bureau of Statistics of China, the *Tabulation on the 2010 Population Census of Shanghai Municipality* shows that in 2010, the urban population of Shanghai is 20.56 million, accounting for 89.3% of the total population of Shanghai, while the rural population only accounts for 10.7%. Furthermore, due to the limitation of