Economic Impacts of a Carbon Tax in China Under Alternative Tax-Design Schemes

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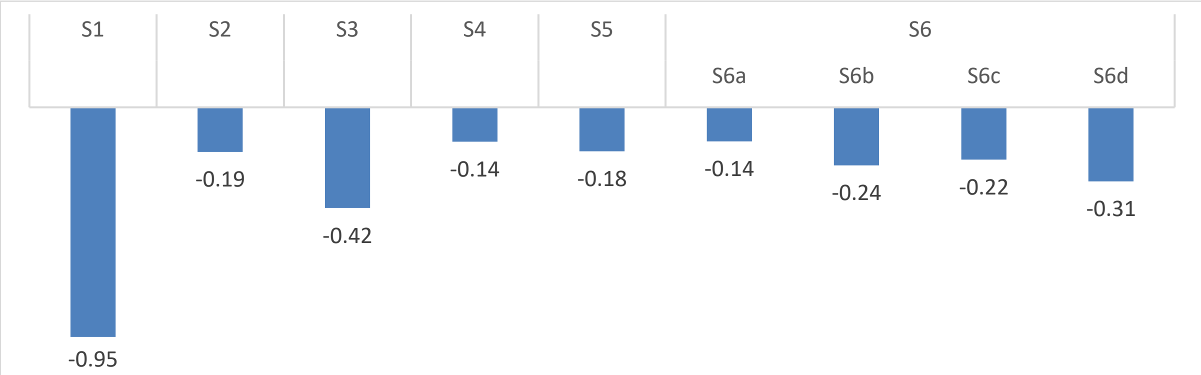
Overview: China updated its Nationally Determined Contributions (NDCs) under the Paris Climate Accord in 2021 and now aims to reduce its emission-intensity of the economy over 65% below its 2005 level by 2030. The new climate change mitigation plan is to peak its CO_2 emission before 2030 and achieve the carbon neutrality of the economy by 2060 (UNFCCC, 2021). Both market (carbon pricing) and non-market (i.e., regulatory or administrative) policy instruments are being considered to achieve the updated NDC targets. As a carbon pricing policy, an emission trading scheme (ETS) has already been introduced for the electricity sector. Other carbon pricing instruments, such as carbon tax, are under discussion. The government's decision on the introduction of a carbon tax might be influenced by several factors, including its overall costs to the economy. A comparison of the economy-wide costs of a carbon tax across alternative tax design schemes and also with that of emission standards would be highly helpful to policymakers. This study examines macroeconomic effects, households welfare, and international trade effects of a hypothetical carbon tax to achieve China's NDC under the nine alternative carbon tax-design schemes (or scenarios). It also compares these effects with those when the NDC will be met through a national CO_2 emission standard. Although there are some recent studies analyzing carbon tax for China (e.g., Zhang et al. 2019; Timilsina et al. 2018; Liu and Lu, 2015;), our study goes much deeper in terms of designing a carbon tax by considering nine alternative design schemes.

Methodology: We developed a multi-sector dynamic computable general equilibrium (CGE) model for the analysis. It explicitly represents the behavior of four economic agents: households, national government, enterprises and the rest of the world. Production sectors in each region are classified into 27 sectors, of which ten are energy supply sectors (coal mining, oil and gas extraction, petroleum refinery, gas processing, and five types of electric power generation – thermal, hydro, nuclear, solar, wind -). The behavior of each production sector is represented through nested Constant Elasticity of Substitution functional forms. Households behavior is represented through a Cobb-Douglas functional form. The model first runs a baseline scenario. This is followed by a scenario (S1) where the government constrains the national CO_2 emission at its NDC target but does not prescribe any specific policy. We then considered a carbon tax under five alternative schemes for tax design. These schemes are: (i) government uses carbon tax revenues as it uses the total government revenues in the baseline (S2), (ii) carbon tax revenues are used to enhance the deployment of solar and wind power (S3), (iii) Carbon tax revenues are used to cut labor taxes (S4), (iv) carbon tax revenues are recycled to households as a lump-sum transfer (S5), (v) carbon tax revenues are used to cut corporate carbon taxes (S6). Design scheme S6 is further divided into four sub-schemes based on the criteria to allocate carbon tax revenues across non-fossil fuel/electricity sectors to cut their corporate tax rates. These are volume of income tax paid by a sector (S6a); corporate income tax rate of a sector (S6b); CO_2 intensity of a sector (S6c), and exports of commodities produced from a sector (S6d). We developed a social accounting matrix of China to calibrate the model using data from the latest (2017) input-output matrices (NBS, 2020).

Results: The key economic impacts of the carbon tax are presented in Figure 1. Chinese GDP in 2030 would be about 1% lower than that in the baseline if the country constraints its national CO_2 emissions at its NDC target without specifying any policy measures (S1). Emitters reduce their GHG emissions the way they find most economical, such as cutting their productions, switching to cleaner fuels and technologies, deploying energy-efficient processes and devices, etc. As expected, the economic costs (i.e., GDP loss) under the carbon tax would be smaller than in the S1 case, no matter how the carbon tax is designed. The economic costs of meeting NDC would be the lowest when carbon tax revenues are recycled to cut existing taxes on labor (S4) and when the carbon tax revenues are used to cut corporate income taxes(S6a). In the latter case, carbon tax revenues are rebated to various non-fossil

fuel/electricity sectors in proportion to the volume of corporate income tax they pay. Recycling the carbon tax revenues to subsidize solar and wind electricity (S3 case) would be instrumental in promoting these clean technologies. However, doing so is the most expensive carbon tax design scheme considered in the study. We also compared our findings with those from existing literature as compiled in Timilsina (2022). Our results further strengthen the importance of proper design schemes for a carbon tax to make it palatable to policymakers and also to taxpayers.

Figure 1. Economic impacts of a carbon tax under alternative tax-design schemes (% loss of GDP in 2030 from the baseline)



Conclusions: Our study first compares general equilibrium effects of a carbon tax with a national CO_2 standard to meet China's updated NDC under the Paris Climate Accord. We then considered nine alternative schemes for carbon tax design and compared them in terms of their general equilibrium effects. The study finds that a carbon tax would be more economical to meet China's NDC target as compared to a national emission standard irrespective of the carbon tax design schemes considered. The carbon tax with tax revenues to cut existing labor taxes or corporate income taxes would be the most efficient when the tax revenues are recycled to a non-fossil/electricity sector in proportion to its labor or corporate income tax volume. Recycling the carbon tax revenues to promote renewables is the most expensive carbon tax design scheme considered in the study.

References

Timilsina GR (2022). Carbon Taxes. Journal of Economic Literature. Forthcoming.

Timilsina GR, J Cao and M Ho (2018). Carbon Tax for Achieving China's NDC: Simulations of Some Design Features using a CGE Model. Climate Change Economics 9(3):1-17.

National Bureau of Statistics (NBS) (2020). China Input-Output Tables 2017. NBS, Beijing.

Liu, Y. and Y. Lu (2015). The Economic Impact of Different Carbon Tax Revenue Recycling Schemes in China: A Model-based Scenario Analysis. Applied Energy, Vol. 141, pp. 96-105.

United Nations Framework Convention on Climayte Change (UNFCCC), (2021). China's Achievements, New Goals and New Measures for Nationally Determined Contribution. shttps://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/China%20First/China%E2%80%99s%20Achievements,%20New%20Goals%20and%20New%20Measures%20for%20Nationally%20Determined%20Contributions.pdf. Accessed on November 1, 2021.

Zhang, K. X. M-M, Xue, K. Feng, Q-M Liang (2019). The economic effects of the carbon tax on China's provinces. Journal of Policy Modeling, Vol. 41 (4), pp. 784-802.