MEASURING MEASURING EFFECTIVENESS OF CARBON TAXON INDIAN ROAD PASSENGER TRANSPORT: A SYSTEM DYNAMICS APPROACH

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Overview

Setting a price on carbon emissions would help to mitigate CO_2 emissions and make people aware towards the proper utilizations of resources. Now more than 20 percent of GHG emissions are subject to carbon pricing systems (Forrister and Bledsoe, 2013)[1]. Putting a price on carbon and taxed it directly, is far better than deciding the limit of emissions through cap and trade system. Over the cap and trade system, carbon tax system has advantages of easy implementation, administration, less cost, predictive carbon prices, revenue recycling, etc (Sterner, 2007)[2]. It is interesting to note that regional schemes to combat CO_2 emissions are getting more effective and popular as compared to global strategies and agreements. UNFCCC has also emphasized on Intended Nationally Determined Contributions (INDC) during the 21st Conference of the Parties (COP21) in Paris during December, 2015. In order to meet emission reduction targets, many countries have announced their INDC. IPCC (2014)[3] suggests that integrating the climate policies with development policies will make implementation easier.

Carbon taxes are highly prevalent and widely acceptable in the culture of Scandinavian countries; it is also used to augment tax revenue which can be used in clean energy fund and in other sources to combat CO_2 emissions. But in developing countries such as India, it is yet to be implemented On July 1, 2010, India introduced nationwide carbon tax as Clean Environment Cess of 50 rupees per metric tonne of coal both for produced and imported. In the budget of 2016-17, Clean Environment Cess has been doubled from Rs. 200 to Rs. 400 per metric tonne from the previous year. The consistent increase in carbon tax shows India’s initiative and active participation in CO_2 emissions reduction.

The combustion of the fossil fuels such as gasoline and diesel is primarily responsible for CO_2 emissions especially in transport sector.The transport sector has 14% share in total energy related CO_2 emissions of India, in which road transport has 80% share (IPCC, 2014). Due to the use of diesel and gasoline in motor vehicles, the air quality of urban areas is getting affected adversely. For emission reduction in transport sector, carbon tax can be levied through many ways such as tax on the manufacturer or on the purchase of a vehicle, on the operation of vehicle, or on the carbon intensive fossil fuels namely diesel and gasoline used in the vehicle. However, the most easier and feasible way amongst the above options is to impose tax on diesel and gasoline. The objective of the study is to measure the impact of carbon tax on fuel to reduce CO_2 emissions from road passenger transport. Further, it also analyses the effectiveness of carbon tax through revenue recycling.

Methodology and Model

To adopt carbon tax as future mitigation instrument in transport sector, it is useful to project and foresee its effect on reduction of CO_2 emissions. A simulation exercise with system dynamics modelling is used to investigate the role of carbon tax on fuel under different tax scenarios. System dynamics is helpful to understand the complex relationships of the transport system arise due to the nonlinear behaviour, time delays in the process, information feedback and complexity in a dynamic system (Sterman, 2000)[4]. It addresses the research gap through identifying the dynamic relationship among road mobility, fuel consumption, CO_2 emissions and fiscal policy instruments. The analysis is done for the period 2000-2015, keeping 2000 to 2011 as a reference period to validate the model. As the price effect may not be effective in reducing CO_2 emissions because of low price elasticity of fuel demand, revenue recycling is introduced in the model through investment in infrastructure, public transport and subsidy to the electric vehicles. With the introduction of tax, the model is extended to low emissions transport. Therefore, the study also captures the role of double dividend. The study uses Vensim PLE software to simulate the system dynamics model for carbon tax on fuel in order to reduce CO_2 emissions. On the basis of causal loop and stock and flow diagram, mathematical equations for each path (depicted in below diagram) have been estimated.

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[1] Forrister, D., and Bledsoe, P. (2013, August 9). Pollution Economics. The New York Times, pp. A19.
[2] Sterner, T. (2007). Fuel taxes: an important instrument for climate policy. Energy Policy, 35(6),3194–3202.
[3] IPCC (2014). Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Cambridge, UK.
[4] Sterman, J. D. (2000). Business dynamics: systems thinking and modelling for a complex world (Vol. 19). Boston: Irwin/McGraw-Hill.

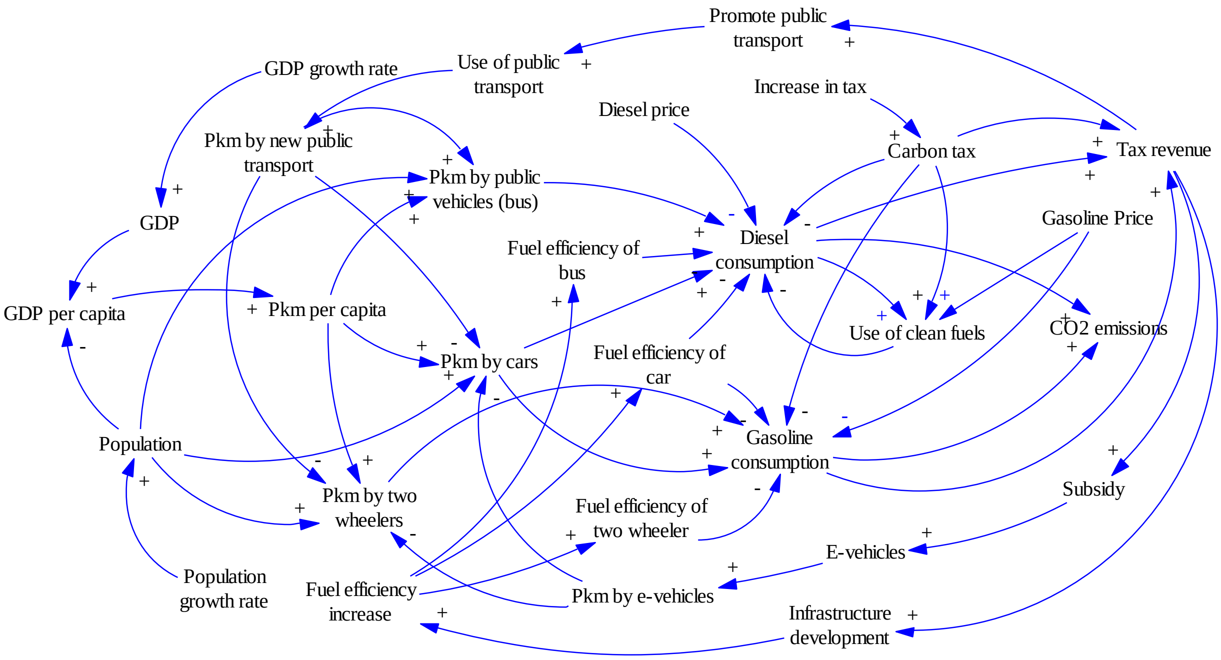

Figure. Causal loop diagram of the system dynamics model for carbon tax on fuel and revenue recycling

Results

The analysis shows that CO_2 emission decreased by around 40% as compared to no carbon tax scenario. In baseline scenario, without any carbon tax, it increased from 94 million ton in 2011 to 245 million ton (around 2.6 times) in 2050. In low, medium, and high tax scenarios, it increased only to 239, 222 and 139 million tonne in 2050, respectively. As compared to the baseline scenario, CO_2 emission has decreased around 26% to 40%. Further, high carbon tax rates are found to be more effective than low carbon taxes. Results show the revenue recycling can be proved as effective tool to make carbon tax a success in reducing CO_2 emissions because price effect in case of India is not strong as price elasticity of fuel demand is low. Further, emerging trend of the economy will lead to increase in passenger vehicles as well as mobility of the people. Therefore, proper combination of charge and compensation would be effective. Further, if we assume 40% fund collected from tax is not properly utilized even then infrastructure development and subsidy of clean fuels and electric vehicles would make carbon tax a success as price effect is weak in case of fuel consumption pattern in India. Findings suggest that policy methods such as revenue recycling (double dividend) would help to exploit synergies and win-win policies in terms of co-benefits from GHG mitigation instruments.

Conclusions

Analysing the prospects of different carbon tax scenarios may assist policy makers to design carbon tax and optimize its effect through revenue recycling. Such policies may have implications for phasing out polluting goods from developing and emerging economies like India. People support taxes only when they are confident that the tax proceedings will actually help in combating CO_2 emission. Therefore, revenue recycling is likely to promote carbon tax and consequently reduce CO_2 emission. Measuring the effectiveness of expected policy instruments would be able to minimize the cost of pollution abatement. Economic Survey (2014-15)[5] estimates that to reduce carbon emissions drastically and to equalize carbon taxes with international standard, there should be around five times increase in the current cess on coal. It further projects that such price increase and tax policy reform would help to reduce 214 million tonnes of CO_2 which consist of 11% of India's annual emissions.

[5] Economic Survey (2014-15). Government of India. From Carbon Subsidy to Carbon Tax: India's Green Actions. New Delhi, India.