

## Estimating Directional Shadow Prices of Air Pollutant Emissions by Transportation Modes

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**Abstract :** This paper applies directional marginal productivity model to study the shadow price of emissions by transportation modes in the years of 2011 and 2013 with the aim to provide a reference for policy makers to improve the emission of pollutants. One input variable (i.e., energy consumption), one desirable output variable (i.e., vehicle kilometers traveled) and three undesirable output variables (i.e., carbon dioxide, sulfur oxides and nitrogen oxides) generated by road transportation modes were used to evaluate directional marginal productivity and directional shadow price for 18 transportation modes. The results show that the directional shadow price (DSP) of SO<sub>x</sub> is much higher than CO<sub>2</sub> and NO<sub>x</sub>. Nevertheless, the emission of CO<sub>2</sub> is the largest among the three kinds of pollutants. To improve the air quality, the government should pay more attention to the emission of CO<sub>2</sub> and apply the alternative solution such as promoting public transportation and subsidizing electric vehicles to reduce the use of private vehicles.

**Keywords :** marginal productivity, road transportation modes, shadow price, undesirable outputs

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