Simulating the Impact of a CO_2-equivalent Meat Tax on Grain and Livestock Markets

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Background

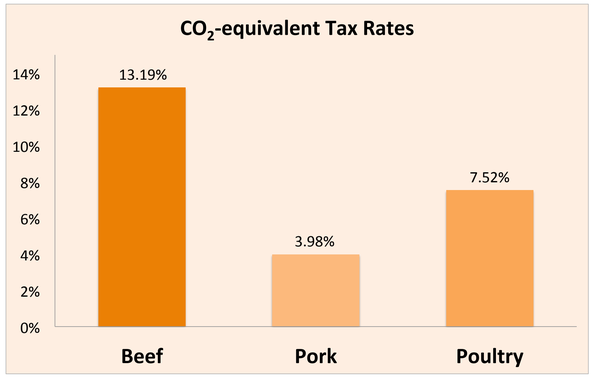
As countries are increasingly recognizing the need to curb greenhouse gas (GHG) emissions in order to mitigate climate change, they have begun to look towards industries like agriculture that have previously been ignored in the climate change discussion. It is estimated that 22% of global GHG emissions originate from agriculture, 80% of which can be traced back to the livestock sector[1]. Global GHG emissions from the livestock sector are estimated to be equivalent to exhaust emissions from all the vehicles in the world, including planes, ships, and land autos[2]. As developing countries continue to industrialize, the projected growth in worldwide meat consumption alone is expected to be enough to push global temperatures past the 2 degrees Celsius danger level that scientists concede will be the tipping point for catastrophic climate change[3]. One policy recommendation for reducing GHG emissions from the livestock sector is to implement an environmental tax on meat consumption[4]. The objective of the tax is to internalize the environmental costs of meat consumption and promote more sustainable diets.

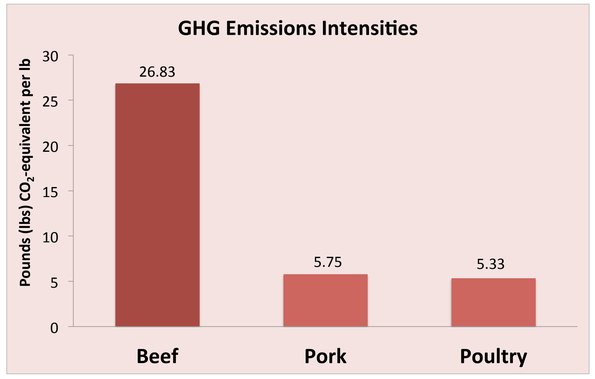
Research Question

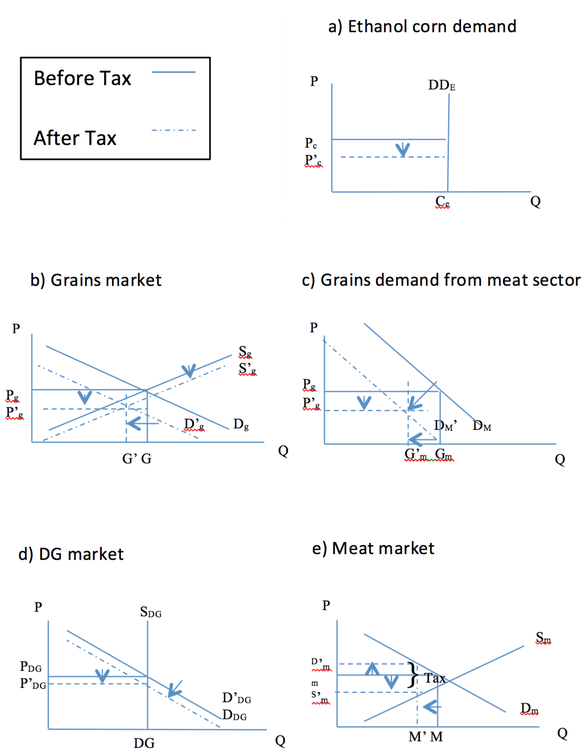
What are the potential effects of imposing a carbon dioxide (CO_2) equivalent tax on meat consumption, including beef, pork, and poultry, on United States (U.S.) livestock and grain markets and GHG emissions?

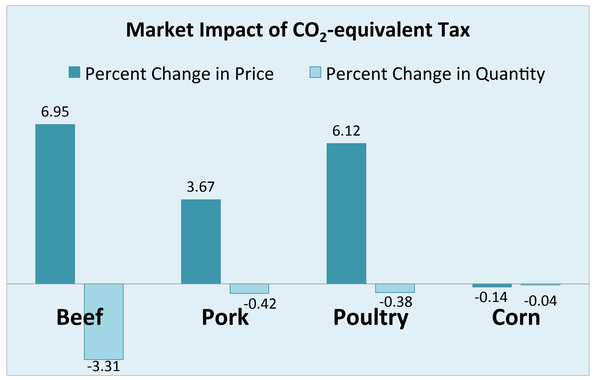
Equilibrium Displacement Model

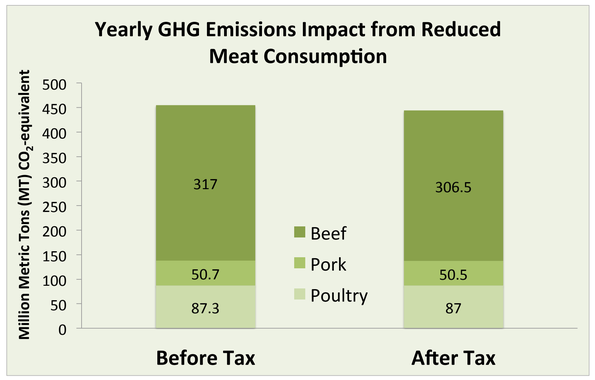
To consider the tax, I have adapted an existing grain and livestock equilibrium displacement model (EDM) developed in part by my UCARE advisor, Dr. Azzeddine Azzam[5]. The EDM is written in matrix form as **Ax=b**, where **A** is a 43 by 43 elasticity coefficient matrix, **x** is a 43 by 1 vector of percent changes in the prices and outputs of the grain and livestock markets, and **b** is a 43 by 1 solution vector used to simulate tax rates, such that $\mathbf{x=A^{-1}b}$. In addition to capturing the linkages between the beef, pork, and poultry markets at retail, wholesale, and farm levels, the EDM includes the linkages between the corn, soybean, distilled dry grains, and ethanol markets. The latter linkages capture the competition between ethanol and livestock for corn.











Impact on Markets

The taxes, which have been calculated by Springmann et al., internalize the GHG emissions from the life cycle of each meat type and the associated social cost of these emissions[6]. All GHG emissions are expressed in terms of their CO_2-equivalents as comparative GHG emissions intensities. Emissions sources analyzed include land use, feed production, livestock production, processing, and transport. The taxes imposed on beef, pork, and poultry are 13.19%, 3.98%, and 7.52%, respectively. Beef faces the highest tax rate, as the GHG intensity of beef is nearly 5 times that of pork and poultry, which have similar GHG intensities. In dollars, the tax on pork and poultry is the same. When converted to a percentage of price, however, the tax on poultry is higher than that of pork due to the relatively lower price of poultry.

With these taxes inputted into the EDM, the following market impacts result:

- **Beef** – The retail price of beef increases by 6.95%, and consumption decreases by 3.31%.
- **Pork** – The retail price of pork increases by 3.67%, and consumption decreases by 0.42%.
- **Poultry** – The retail price of poultry increases by 6.12%, and consumption decreases by 0.38%.
- **Corn** – The price of corn decreases by 0.14%, and corn usage decreases by 0.04%. Corn is included as a representative of the U.S. grain market.

Impact on Emissions

To calculate total U.S. GHG mitigation potential resulting from the tax, I used Springmann et al.'s data on GHG intensities of beef, pork, and poultry in combination with U.S. Department of Agriculture data on yearly disappearance of each meat type[6,7]. The total GHG mitigation potential resulting from the tax is 11 million MT CO_2-equivalent per year. This would reduce total U.S. GHG emissions by 0.17%, which is the equivalent of taking 2.3 million cars off the road each year[8,9].

References

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