Market-Mediated Land Use Change Consequences Of Crop-Based Biofuel Production

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INTRODUCTION

Growing biofuel feedstocks on prime agricultural land influences the global food system and causes indirect, off-site changes in land use and land cover via agricultural market signals. In addition to emissions of greenhouse gases, these changes affect biodiversity, regional climate, soil quality, and water quality.

New biofuel and low-carbon fuel policies, such as the Energy Independence and Security Act of 2007 and California’s Low Carbon Fuel Standard, require that the life-cycle greenhouse gas emissions of fuels be measured and reported. In addition, there are several efforts under way to establish sustainability criteria for biofuels. Thus it is essential that we understand the indirect effect of biofuel production on land use and land cover, as well as the impacts of those changes on greenhouse gas emissions and other sustainability metrics.

Estimating market-mediated land use effects requires both economic and bio-physical models, which are fraught with methodological challenges and data uncertainties. Characterizing these uncertainties will inform the policy making process and guide research toward issues that will increase the ability of decision-makers to mitigate climatic and ecological effects of new fuels.

SIZE OF EFFECT

Searchinger et al 2008 demonstrated that the indirect land use emissions of biofuels may be very large, possibly outweighing all other sources of greenhouse gases in the life-cycle of corn ethanol and switchgrass ethanol grown on prime cropland.

PRELIMINARY RESULTS

We performed monte carlo simulation on the land use analysis of Searchinger et al. 2008. The economic modeling results were held constant, while assumptions about the partition of ecosystem types affected in each region were varied along with assumptions about above-ground carbon stocks, soil carbon stocks, and the percentage of soil carbon lost due to conversion. We examined the literature cited by Searchinger et al. to estimate distributions for each of these parameters. We found that uncertainty in physical parameters did not qualitatively affect the result that corn ethanol and switchgrass ethanol grown on corn land create more greenhouse gas emissions than gasoline.

DISCUSSION

The market-mediated climatic land use effect of crop-based biofuels appears to be very large and policies seeking to mitigate climate change via biofuels must consider it. While uncertainties in physical parameters such as carbon stocks did not qualitatively influence model results, uncertainties in the economic model have the potential to do so, particularly if a larger share of the demand shock is met by intensification and substitution rather than extensification. More research is needed to characterize and resolve the uncertainties in modeling this complex phenomenon.