Analysis of Global Economic and Environmental Impacts of a Substantial Increase in Bioenergy Production

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Introduction

With the growing concerns on energy security and climate change, biofuels have witnessed rapid increase in production in rich countries particularly in the United States and the European Union. Massive subsidies offered by these countries, have resulted in large-scale implementation of biofuels programs which have profound global economic, environmental, and social consequences. Current studies do not provide much insight into how alternative bioenergy production scenarios could change global agricultural production nor the incomes of affected groups both within and across nations. The increasing importance of biofuels and lack of comprehensive studies on global impacts have opened up several research avenues. Since biofuels are produced mainly from agricultural sources, their effect is largely felt in agricultural markets and land-use, with repercussions for international trade. As the World Bank reports, nearly 70 percent of the world's poor live in rural areas in developing countries and derive their primary livelihood from agriculture. Higher biofuel feedstock prices can help the farmers who grow them, but an increase in food prices can hurt the poor as they spend a large share of their budget on food. Keeping these issues in view, this project aims to develop a realistic assessment of the economic and environmental impacts of regional and global policies designed to stimulate biofuels production and use. This project will be completed over a three-year period. The project builds on the unique strengths of the Global Trade Analysis Project (GTAP) based at Purdue University.

Analytical Framework

A Computable General Equilibrium (CGE) modeling in GTAP framework (Hertel, 1997) is adopted as it is best suited for studying the global, socio-economic impacts of biofuel technologies and policies. The GTAP database and its analytical framework are widely used for analysis of global trade, energy, environment, technical change, and poverty issues in an economy-wide context. In order to evaluate alternative bioenergy scenario impact on land-use, potential land for feedstock and other crops production, water availability and greenhouse gas (GHG) emissions, we utilize the Terrestrial Ecosystem Model (TEM), a widely used model in ecological research. The resulting factor earnings and commodity prices from the interaction of economic and environment modules are translated through the poverty module to determine the change in poverty headcount, by population strata in a sample of 15 developing countries. In all, through this project, we will be able to empirically evaluate the impacts of biofuel policies in the U.S., EU, and Brazil on the global economy, focusing on impacts on agricultural markets, global poverty and environment.

Research Progress and Preliminary Results

We have incorporated three explicit biofuels sectors such as corn-based ethanol, sugarcane-based ethanol, and vegetable oil based biodiesel, in to the GTAP data base (Dimaranan, 2007 and Taheripour *et al*., 2007). In order to introduce biofuels as energy substitutes/complements into the GTAP model, we use GTAP-Energy model (Burniaux and Truong 2002; McDougall and Golub, 2007) linking with Agro-ecological Zones (AEZs) (Lee *et al*., 2005) for each of the land using sectors. The GTAP-E model with biofuels and AEZs provides a clear picture regarding the impacts of growing importance of biofuels on global changes in crop production, utilization, prices, factor movements, trade, land-use change etc. For validation of the model, we project a hypothetical biofuel economy forward in time and compare the model predictions with historical evidence from 2001 to 2006. We focus on three main drivers of biofuel boom in the U.S.: hike in crude oil prices, replacement of MTBE by ethanol in gasoline additives, and subsidy for

ethanol. Using this historical simulation, we calibrate the key elasticity of energy substitution between biofuels and petroleum products in each region. With these parameter settings, the model does a reasonably good job of predicting the share of feedstock in biofuels and related sectors in the major biofuel producing regions.

As an illustration, we analyze the impact of implementation of biofuel mandates for 2010 in the U.S., and EU. The European Union has set the goal to reach a biofuel share of 5.75% in transportation fuels market by 2010. The United States is considering a target to reach about 35 billion gallons of biofuels by 2017. We adopt these targets for a "mandates" simulation for the year 2010. Both of the regions are expected to substantially increase the share of agricultural products utilized by the biofuels sector. For example, the corn share in ethanol production could double from 2006 levels in the U.S. (Figure 1). Similarly, share of

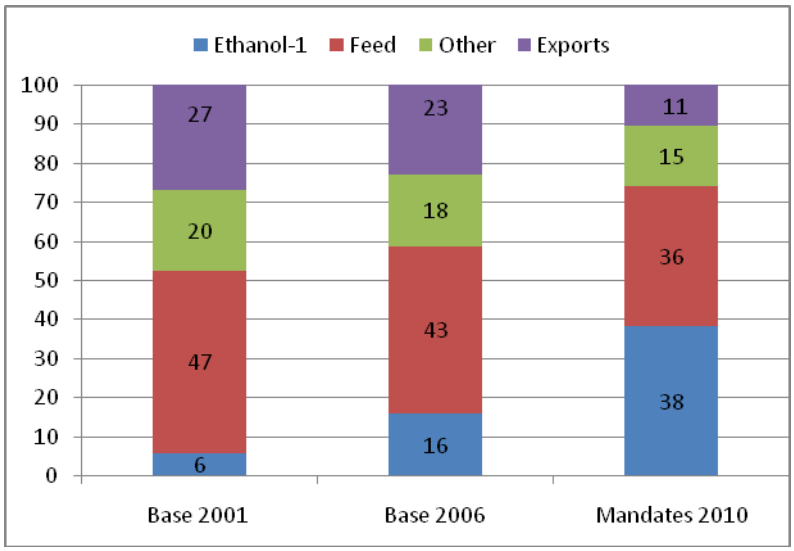

Figure 1. Disposition of Coarse grains in the U.S. (%)

oilseeds going to biodiesel in the EU triple with doubling the price of these feedstocks from 2006 levels and sharply reducing their exports from these two regions. In the EU, the majority of the biodiesel driven demand for oilseeds is met from imports, with import volume rising by more than $4 billion. These increases in biofuels demand also have profound influence on agricultural production and land-use. An 11% increase in corn acreage from 2006 in the U.S. results in significant falls in wheat and soybean acreage along with other crops, livestock, and forestry land use. The acreage devoted to oilseeds in the EU increases by 21%, which comes at the cost of forestry and other crops. The combined impact of US and EU biofuel mandates puts considerable pressure on agriculture and forest lands throughout the world. Due to slight decline in import of petroleum products, the trade balance improves for the U.S. Overall, the biofuel mandates in the US and EU are likely to have significant and lasting impacts on the global pattern of agricultural production and trade.

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