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Indirect Land Use: One Consideration Too Many in Biofuel Regulation

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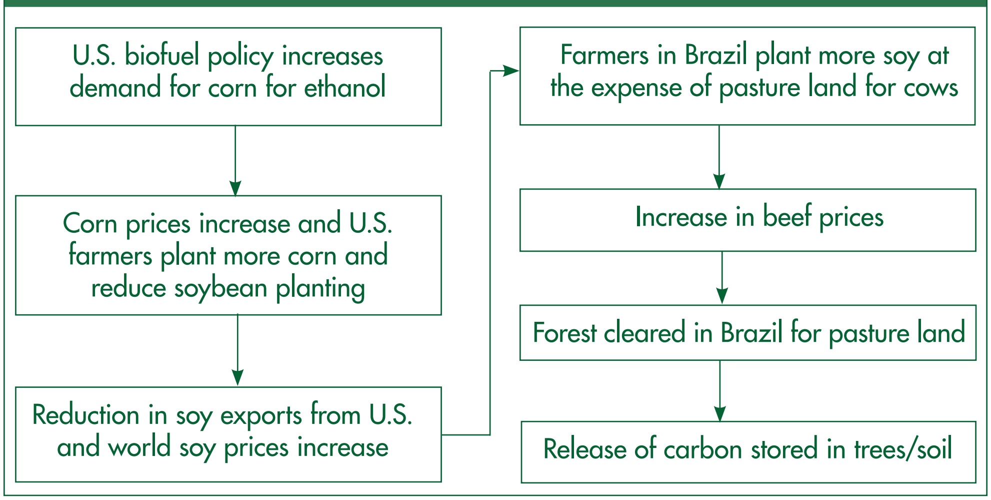
Allocation of agricultural commodities like corn to produce biofuels (ethanol)—leads to higher corn prices, which may lead to expansion of corn acreage and ultimately expansion of agriculture resulting in extra greenhouse gas (GHG) emissions from land use. These extra emissions are what are referred to as indirect land-use effects (ILUEs) of biofuels. This paper argues against the current practice of considering ILUEs of biofuels in the current California and Federal regulations of biofuel. The indirect land uses are uncertain, vary over time, and their current estimates diverge significantly.

Also in this issue

One of the major objectives of renewable fuel policies in the United States is to introduce alternative fuels that reduce greenhouse gas (GHG) emissions relative to fossil fuels. Thus, the Energy Independence and Security Act of 2007 (EISA) requires that transportation fuels sold in the United States contain a minimum volume of biofuels and requires a national renewable fuel standard (RFS). Enforced by the U.S. Environmental Protection Agency, the RFS sets an upper bound on GHG emission per unit of various biofuels. For example, corn ethanol meets the RFS if (after the appropriate adjustments) it reduces the GHG emission by 20% relative to gasoline. Another major regulation of biofuels is the low carbon fuel standard (LCFS), which, unlike the RFS, concerns all fuels. It was introduced by California as part of AB32 and is under consideration by other states and also the EU and China. The California standard requires reduction of the average GHG emission of fuels by a certain percentage each year until attaining the eventual target of 10% reduction by 2020.

The GHG emission of different fuels in these regulations is calculated using life cycle analysis (LCA). Traditionally, this technique calculates all the emissions that are generated throughout the life of a biofuel, including the emissions generated in production of fertilizers, plowing of the fields, harvesting, processing, as well as burning of the fuel. However, a unique feature of biofuel regulation is that the traditional LCA is augmented to account for the indirect land-use effects (ILUEs) associated with the production of biofuel. For example, if producing biofuel from corn led to the expansion of agricultural land and conversion of rangeland or forest to agriculture, this ILUE is considered as part of the LCA. One possible pathway leading to land-use change is shown in figure 1 on page 2. The idea that biofuel regulations needs to take into account the ILUE was motivated by an influential paper by Searchinger et al. (2008). This notion is based on the basic properties of market behavior. In particular, when the demand for a product like corn is expanding, in our case because of the introduction of biofuels, the increase in the price of the product leads to increased supply. The increased supply of corn may lead to land conversion to agricultural production, and this process of expanding the agricultural land base leads to release of extra GHG emissions. These extra GHG emissions have to be calculated as they are the indirect land-use components of the LCA of biofuels. Figure 1 provides a graphical presentation of the LCA and the indirect land uses of biofuels. While including ILUEs in assessing the impact of biofuel seems appealing, we will argue here against an indirect land use in biofuel regulations for the basic reason that its inclusion in LCAs contradicts a basic principle of regulation—namely that individuals

Figure 1. One Pathway for Indirect Land Use Change



are responsible only for actions that they control. The indirect land uses are difficult to compute and vary over time. Finally, there are other indirect effects of biofuels that are not included in the LCAs of biofuel, and thus the inclusion of indirect land use is inconsistent with other regulatory criteria.

Use of Indirect Land Use Contradicts the Sound Principle of Policy Design

The technical difficulty in estimating indirect land use is only one reason why this concept is not appropriate to use in regulating biofuels. Economists introduced the notion of an externality. It occurs when the activities of one economic agent, say a farmer, has an unintended effect on the well-being of others. They distinguish between technical and pecuniary externalities. Negative technical externalities occur when, for example, waste materials from farms contaminate the water of a nearby fishery. In this case, economic theory suggests it is socially desirable that the polluters will take into account the extra contamination cost in choosing their activities.

Pecuniary externalities occur when the activities of a group of economic agents affect the well-being of others through markets by changing prices. When the industry is competitive—and, for example, when a group of economic agents increases their demand for a product, the price of the product increases, and more of the product will be produced. Other buyers of the product will suffer from the pecuniary externality (the price increase). Economic theory suggests that the industry shouldn't be responsible for the impact of the rising prices. Moreover, if the increase in production will result in more pollution, namely a technical externality resulting from the pecuniary externality, then economic theory suggests that policy intervention should be enacted to modify the polluting activities of the producers of the extra supply.

The difference in the treatment of technical and pecuniary externalities is that producers control their production and hence their pollution. But in a competitive market, they don't control the prices. This reflects a basic principle: Individuals should be responsible for activities that they control and not for those that they don't.This basic message of accountability suggests that producers of biofuel shouldn't be held responsible for indirect land-use decisions made by others.

The use of a traditional LCA for environmental regulation is justified on informational and control considerations. The production of biofuel may involve supply chains with many entities that are vertically linked through contractual arrangements. When the final seller of biofuel, say an oil company, is held accountable for the life cycle emission, it may be much more effective in obtaining information and affecting choices throughout the supply chain than a government entity when it attempts to regulate each entity separately. Holding the final seller of a supply chain responsible for emissions and other externalities throughout the supply chain is a growing tendency that has led to increased emphasis on traceability and resulted in regulations based on LCA in other sectors of the economy. While the sellers of the biofuels are aware and can affect the behavior of their suppliers and other agents up the supply chain, they cannot affect the choices of producers in another industry (farmers in Brazil), and the indirect land use lacks one of the advantages of the use of traditional LCAs in regulating biofuels.

Furthermore, there is a related flaw in the use of indirect land use for regulating biofuels. Basic principles of public economics suggest that all emitters of GHGs in the world are held responsible for their own activities. The indirect land-use approach holds farmers responsible for possible emissions by farmers elsewhere. Searchinger et al.'s arguments imply that since the Brazilian government may not fully control deforestation in the Amazon, we should make sure that U.S. biofuel producers would be held responsible for activities that will raise the price of corn and soybean and may lead agents in Brazil to deforest the Amazon and increase GHG emissions. It makes more sense to strive to enact policies that will make Brazil, or any other country, responsible for the GHG emissions associated with land-use changes in their countries through international agreement, rather than make agents in the United States, or elsewhere, responsible for the lack of action in Brazil. It is impractical to assume that by modifying the biofuel policies in the United States, one can forever protect the tropical forests in Brazil or anywhere. There is an old principle of policymaking that each policy tool should concentrate on controlling a policy objective. When LCA regulations aimed to control the choices of biofuel suppliers to the U. S. market, and also are designed, at least implicitly, to affect land-use choices of other agents, they are likely to underperform in all tasks. Biofuel policies are part of a set of land-use policies that try to achieve multiple objectives including control of GHG, preservation of biodiversity, provision of environmental amenities, and production of food and fiber within a globalized economy. Whenever market prices do not capture social costs or benefits, specialized policies should be designed to address the technical externalities of biofuels, land-use expansion, and biodiversity preservation.

The ILUEs of Biofuels Change Frequently and Are Difficult to Implement

Recent attempts of computing the ILUEs of biofuels have encountered some problems. First, different studies derived significantly different estimates of the ILUEs. For example, a forthcoming study by Hertel et al. (2010) estimates the magnitude of the ILUE of biofuel to be one-third of the one estimated effect by Searchinger et al. (2008). This is not surprising since the computed change in land use and emission of GHGs is based on responses to commodity prices, which are diverse and have varied drastically between countries and among crops over time. Higher commodity prices may lead to increased agricultural acreage and/or intensification of agricultural production by adoption of more efficient production technologies or increase in the use of inputs like fertilizers. Land-use changes are more likely to contribute significantly to increased overall agricultural supply in periods of low rates of change in agricultural productivity and be less important in periods of large gain in productivity. The recent study by Alston, Beddow, and Pardey (2009) suggests that the changes in agricultural productivity vary significantly among regions and over time.

Further, changes in productivities are strongly affected by policy. Zilberman et al. (1991) suggest that banning the use of pesticides, for example, might have led to a strong increase in acreage, as yield per acre would have declined. A recent study by Sexton and Zilberman (2010) suggests that the adoption of genetically modified (GM) corn, soybeans, and cotton increased yield substantially. In the absence of this productivity increase, acreage would have been rising. They calculate that without the adoption of GM crops, some prices of agricultural commodities, like corn, would have risen by 30%. They also argue that if the practical ban of biotechnologies in European and African countries had been removed, much of the increase in food prices attributed to biofuels would have been eliminated. Historically, agricultural production has grown much faster than arable land. According to Federico (2009), the world agricultural production more than tripled between 1950 and 2000, while acreage in arable land and tree crops grew by less than 25%. U.S. agricultural acreage peaked around 1920 and, even though productivity output has increased by ten- fold since then, the acreage has declined.

Computation of the ILUE does not end in estimating the expansion of agricultural land because of biofuel. It requires quantitative understanding of the conversion of various ecosystems (forest and pasture) to agriculture and their implications on GHG. There is a big difference from the GHG perspective whether an increase in the acreage of corn would result in conversion of old-growth forest or wildland to farming. Some of the increases in soybean acreage in South America in recent years were “virtual” increases, namely farmers started double-cropping soybeans following wheat, which might have led to carbon sequestration and reduce GHG emissions. The uncertainty about the conversion of ecosystems to farming is a major reason for the differences between indirect land-use estimates. However, the conversion processes and their GHG implication can be affected by policies and technologies. Better enforcement of policies to control deforestation, as well as incentives for carbon sequestration, may drastically affect the GHG impact of agricultural expansion because of biofuels.

Thus, it would be very difficult to predict the ILUEs of specific biofuels as they are unstable—affected by changes in weather, economic conditions, and knowledge. They can also be influenced by policy choices; for example, more investment in agricultural research, more liberal regulation of biotechnology, or changes in the deforestation and land-use policies.

Consistency and Incentive Considerations

The introduction of indirect land use in the context of biofuel is inconsistent with other types of policies. The introduction of biofuel has other indirect effects through the markets. For example, one can consider the indirect fuel price effects associated with biofuel. Recent studies suggest that the introduction of biofuel has reduced the price of fuels by 1–2%, which results in extra driving and an increase in congestion and GHG emissions. On the other hand, by reducing the price of fuel, the introduction of biofuel may make it less profitable to invest in oil produced from tar sands and to convert coal to oil. This may reduce GHG emissions because conversion of tar sands for oil is highly contaminating. Furthermore, the increase in supply of biofuels may lead the Organization of the Petroleum Exporting Countries (OPEC) to reduce some of their production activities.

And again, the indirect effect through the markets also affects GHG emissions.

So, if we start to consider some indirect effects on GHGs associated with biofuel, we should consider them all. But, then where lies the end? And how can we calculate them all? Why should we hold producers responsible for things that they cannot control? There is another source of inconsistency that one has to recognize when considering indirect land use. The conservation reserve program (CRP) in the United States, and other reserve programs are improving environmental qualities—and providing a significant amount of ecosystem services by diverting land from agricultural production and, in many cases, the production of corn and soybean. By taking corn and soybean out of production, the CRP has indirect land-use effects that may lead to expansion of production in other parts of the world with negative environmental impacts. Are these ILUEs taken into account when farmers' proposals for diversion of land through CRP are evaluated?

Biofuels, to a large extent, are works in progress. Our methods of crop production, processing, conversion, and utilization of biofuels are far from perfect. We rely on first-generation biofuels that, in some cases, may generate more GHG emissions than they sequester. However, at the same time, we aim to encourage technological development that will improve the GHG performance of existing biofuels, which leads to introduction of more sustainable second-generation biofuels. We allocate a large amount of public research, but these technologies will not be improved and introduced without major private investment. The introduction of biofuel plants is subject to incentives and regulations, and it is expected that the GHG performance of the new facilities will be far superior to that of the current facilities.

However, indirect land uses introduce uncertainty because the performance standards under which new facilities will be judged will not be controlled by their own design, but by the performance of other actors that they cannot control. Increased uncertainty is a disincentive for investment, and indirect land use may inadvertently lead to underinvestment in second-generation biofuels or improvement in current biofuels. From an investor's perspective, it may be more sound to have policies that become stricter over time than policies that are inherently uncertain. Thus, the indirect land use that is part of the attempt to reduce GHG effects of biofuels may have the opposite effect by providing this incentive to invest in new and cleaner biofuel technologies.

Conclusions

The indirect land-use concept reflects good intentions, but has many practical and logical flaws. When individuals are regulated based on the indirect land use of their biofuels, they become responsible for actions that they do not control. Current policies are inconsistent since they consider one type of indirect effect of biofuels while ignoring others. The ILUEs of biofuels are unstable, may vary significantly over time and with policy choices, and are difficult to implement. Their inclusion in biofuel regulations introduces unnecessary uncertainty about future regulations, which hampers investment choices. Thus, the use of indirect land use in the current regulations of the GHG emissions of biofuels represents a well-intentioned, unilateral effort to control one aspect of climate change, but it may be counterproductive.

Removal of ILUEs from LCAs will present an improvement of biofuel regulations. But stand alone, biofuel or renewable fuel policies not integrated with controls of other GHG emissions, are far from ideal. Climate change is a global problem requiring consistent policy responses throughout the world. Efficient control of climate change requires equilibrating the implied prices of GHG emissions across activities. Designing procedures and mechanisms to further improve biofuel utilization and prices is an important subject for future research and policymaking.

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