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Why Sustainability Standards for Biofuel Production Make Little Economic Sense

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Executive Summary

The federal "sustainability standard" requires ethanol to emit at least 20 percent less carbon dioxide (CO_2) than gasoline. Recent rulings by California and the Environmental Protection Agency, however, have cast doubt on the methodology of the sustainability calculus and whether those standards are being met. We show that the methodological debate is misplaced because sustainability standards for ethanol are, by definition, illogical and ineffective. Moreover, those standards divert attention from the contradictions and inefficiencies of ethanol import tariffs, tax credits, mandates, and subsidies, all of which exist whether ethanol is sustainable or not.

Ethanol is sustainable by definition. The CO_2 sequestered by growing corn is exactly offset by the CO_2 emissions that follow from burning the fuel in a car. The same observation applies to, say, consuming bourbon made from corn, but ethanol can replace energy—bourbon cannot. Hence, any sustainability standard should be applied to all corn and other crop products, and not just ethanol.

Sustainability standards are based on "life-cycle accounting," in which ethanol is assumed to replace gasoline; but in fact, it may be replacing coal or other energy sources. Life-cycle accounting also fails to recognize that if incentives are given for ethanol producers to use relatively "clean" inputs (e.g., natural gas), the "dirtier" inputs (e.g., coal) that might otherwise have been used for the ethanol production will simply be used by other producers to make products that are not covered by the sustainability standard. Sustainability standards reshuffle who is using what inputs—with no net reduction in national emissions.

Finally, sustainability standards are discriminatory under World Trade Organization law and are unlikely to survive a legal challenge from ethanol producers abroad. The United States will not be able to rely on the World Trade Organization's exception for trade laws protecting the environment because of lax U.S. policies dealing with greenhouse gas emissions relative to its trading partners. Moreover, the imposition of U.S. tariffs on more climate-friendly ethanol produced abroad weakens any U.S. defense of ethanol sustainability standards under the WTO.

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Introduction

The U.S. sustainability standard currently requires ethanol production to emit at least 20 percent less CO_2 than the gasoline it is assumed to replace. The biofuel market is currently in turmoil over sustainability standards, however, because the U.S. Environmental Protection Agency and the European Union are overdue in adjusting existing greenhouse gas emission rules.[1] These rules are based on "life-cycle accounting" (LCA), a "well-to-wheel" measure of greenhouse gas emissions in the production of gasoline (diesel) and an analogous "field-to-fuel-tank" measure for ethanol (and biodiesel) production. The current controversy revolves around the effects of indirect land use changes and whether or not they should be included in the LCA measures. The choice of a sustainability standard for biofuels is deemed a crucial environmental policy decision and the debate has reached a fever pitch.

This Q&A demonstrates that sustainability standards based on LCA—with or without the consideration of indirect land use changes—will at best be ineffective and, accordingly, will provide little guidance to policymakers. Worse still, it can be misleading, while at the same time serving to divert attention away from more important biofuel policy issues like tax credits, import tariffs, adding tax credits to mandates, and production subsidies for either the feedstock or the biofuel.

1. How can ethanol be "sustainable" in the first place?

There is a scientific law akin to the law of thermodynamics: the CO_2 sequestered in growing the crop used for biofuel production is exactly offset by the CO_2 emitted when the automobile combusts the biofuel. Ethanol is therefore a "net zero" in CO_2 emissions, just like the production and consumption of other corn products, like bourbon (henceforth in this paper, we will use "bourbon" as a catchall term for all products other than biofuels that are produced from corn and other crops). Some uses of land are net positive from a greenhouse gas perspective (e.g., forests, which sequester and store CO_2), while others are net negative (parking lots). But if you burn a fossil fuel (oil, natural gas, or coal), 100 percent of the carbon in that fuel is emitted, nearly all of it as carbon dioxide.

2. So why have a sustainability standard on biofuels when they are a net zero in CO_2 emissions?

You shouldn't! There is no logic in having a sustainability standard for ethanol (or a CO_2 tax on it), or on bourbon production, for that matter.

3. But isn't it true that more CO_2 is sequestered when growing the crop than is combusted when consumed?

That is possible. For instance, CO_2 can be sequestered in the ground when employing some types of soil tillage practices. There might also be some CO_2 savings associated with electricity production from leftover biomass wastes.

4. So isn't ethanol therefore net negative in CO_2 emissions?

In some cases, yes. But that observation alone does not justify a subsidy for ethanol. In these cases, the optimal policy response would be to subsidize (or provide carbon offsets for) the practices (e.g., no-tillage crop production) that result in carbon sequestration. Ethanol production with those practices may produce emission reductions. Ethanol production without those practices may not.

5. So are you saying ethanol and bourbon should be treated equally and that if there is a sustainability standard on ethanol, there should also be one on bourbon?

That is correct. Any sustainability standard for ethanol production can only have one of two possible effects: none (ethanol passes the test), or it discourages the production of ethanol

(ethanol fails the test). Any such standard should also therefore be extended to bourbon. There is simply no reason to regulate CO_2 for some uses of corn but not for others.

6. I chanced to come across a quote from some European politician who wrote: "Why should we suggest there is an obligation on producers who export sugar cane biofuel, but not on those who export plain sugar cane?"[2] What do you think of that statement?

This is consistent with our discussion so far and emphasizes how sustainability standards for biofuel production are problematic when you exclude standards for all other products using, say, corn, in the United States. Corn is used for bourbon, beef, bacon, Buffalo wings, butter, and the high-fructose corn syrup used in Coca-Cola. Imposing a sustainability standard on corn used for ethanol production but not on other uses of corn seems almost absurd and has no basis in logic or economics.

7. But the current U.S. sustainability standard for ethanol production requires a reduction in CO_2 emissions; how can that be possible when you say ethanol production is net zero in CO_2 emissions?

It is assumed that ethanol replaces gasoline.

8. If ethanol replaces gasoline, isn't there a net CO_2 emission savings of 100 percent? Why do you keep saying that ethanol is net zero?

If you assume that ethanol replaces gasoline, as current sustainability standards do, then you are correct—there is a net CO_2 emission savings of 100 percent. Bourbon is still net zero because it cannot replace gasoline (drinking laws reduce driving and so bourbon consumption reduces CO_2 emissions, but we should not get fancy and start measuring indirect use changes).

9. Are you saying that ethanol is always better than bourbon in terms of CO_2 emissions?

Yes, because remember, an ethanol sustainability standard can only do one of two things: nothing, or discourage ethanol production. Because ethanol will replace at least some gasoline, or other forms of energy, then we should have a more stringent sustainability standard on bourbon production (and on the production all other corn products like beef, bacon, butter, etc.) in order to be consistent. But instead, we have sustainability standards on ethanol alone, which is contradictory.

10. But doesn't ethanol replace gasoline?

Yes, we suppose, maybe. It may replace natural gas or coal instead. It all depends.

11. What do you mean "it all depends"?

LCA assumes ethanol *replaces* gasoline. But the conditions under which this would occur are extreme. An economist would immediately think of *indirect use* changes: ethanol production may not replace gasoline, it may displace gasoline and gasoline may *replace something else* like coal. In other words, this gasoline that LCA assumes is saved may be used elsewhere instead.

Although we are new to the study of energy markets, there are two stylized facts that come up in the literature. The first is that oil supply is generally thought of as "finite" while coal is considered "unlimited in supply." In "econ-speak," this means the supply curve for oil is vertical and the supply curve for coal is flat. If this is true, then ethanol does not replace any gasoline in this scenario but replaces coal instead (see Figure 1—the total energy consumption does not change because we assume all sources of energy are perfect substitutes in demand on the margin—energy is energy).

Coal emits 40 percent more CO_2 per BTU than oil and other greenhouse gases. Hence, if U.S. ethanol production displaced coal rather than oil, the CO_2 savings would be larger than advertised at present. Moreover, U.S. coal is exported around the world, so if those exports increased due to ethanol production, perhaps it would replace the dirtier (high sulfur) coal in

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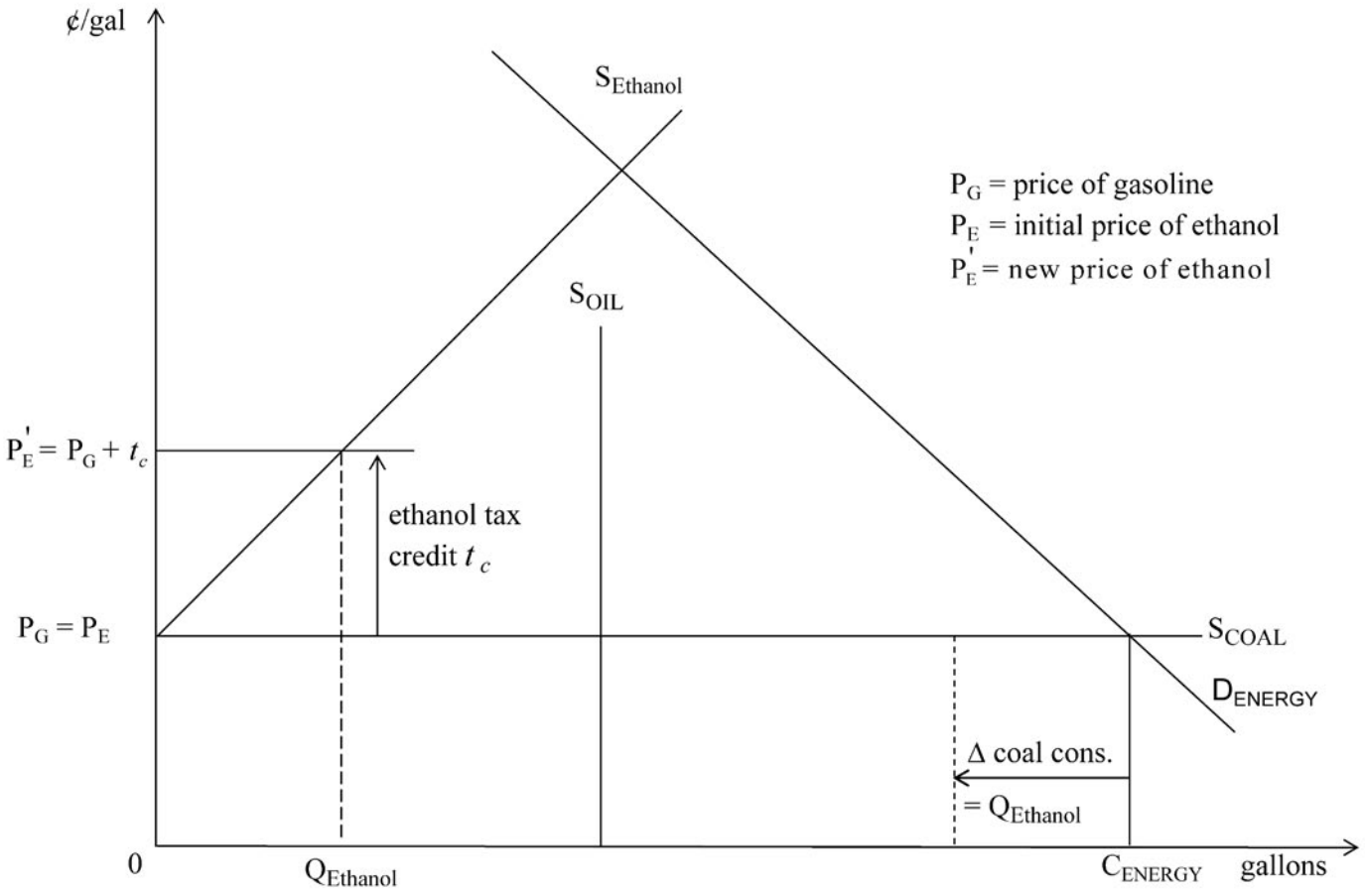
Figure 1
How Ethanol Production May Replace Coal Consumption



China and elsewhere, which in turn results in even more greenhouse gas emission reductions.

Ethanol production in Brazil also results in more greenhouse gas savings than those that follow from gasoline substitution. Electricity in Brazil is generated by harnessing leftover sugar-cane biomass, thereby potentially replacing coal-based electricity consumption there as well. Besides, it is possible for biofuels to displace wood currently used for home cooking and heating in developing countries. This is a good thing; wood burning is currently imposing huge health and environmental costs.

Furthermore, livestock production accounts for 70 percent of all agricultural land use worldwide. Ethanol production in Brazil will reduce livestock production by reducing pasture land use and increasing feed costs, thereby generating further savings in greenhouse gas emissions (cattle cause more greenhouse emissions than transportation fuels worldwide).

So, the bottom line is that LCA measures are not accurate when they ignore all these factors.

12. Do you mean to say we should just leave ethanol alone?

No more than we should leave gasoline alone for contributing to, for example, externalities that are a function of miles traveled, like traffic congestion. Ideally, traffic congestion would be dealt with by a time-varying toll. But if this is infeasible due to political or administrative con-

straints and a volumetric fuel tax is used instead (as in most countries), then ethanol should only pay 70 percent of such a tax, because you get about 30 percent fewer miles from a gallon of ethanol compared to gasoline.

13. The current U.S. sustainability standard requires ethanol production to reduce greenhouse gas emissions by 20 percent, yet you say that ethanol production is either net zero or has a savings of 100 percent. What is going on here? I do not understand—this is confusing.

The answer is that for a heretofore unknown reason, physical scientists (and regretfully, now economists) began measuring the amount of greenhouse gas emissions from "cradle to grave" using a type of input/output analysis called "life-cycle accounting." LCA measures the greenhouse gas emissions from the use of oil, coal, and natural gas in the production of ethanol (e.g., to power the tractor in corn production, produce the fertilizer, process the corn into ethanol, and transport the final product to the retail fuel pump). A similar exercise is done for gasoline production. Then these numbers are added up, and presto—there is an average of 20 percent savings in greenhouse gas emissions for corn-ethanol production in the United States relative to the gasoline it is assumed to replace. This is what the current legislation on sustainability is based upon.

14. Is it not difficult to measure all of the greenhouse gas emissions directly used in the production of ethanol and gasoline?

It is not too difficult—it is simple physical input-output analysis. But there are plenty of tricky things to consider. For instance, do you measure greenhouse gas emissions for gasoline using oil from Saudi Arabia or from gasoline using oil from tar sands in Canada? For ethanol, do you use data from a modern ethanol plant or from the industry average? Different choices can produce wildly different results. The Brazilian trade association UNICA, for example, has just responded to the recently released California low-carbon fuel standard by showing that a common greenhouse gas emission estimate for sugarcane ethanol is 66 percent too high because it omits the switch to mechanized harvesting, assumes neither excess bagasse nor co-generation, and is in error regarding land-use changes that follow from ethanol production in Brazil.[3]

Moreover, any standard will have to deal with significant future improvements in productivity in both sugar cane and ethanol production in Brazil. where there is a significant "yield gap" (which is zero for U.S. corn production). Having said that, the International Energy Agency just came out with a report predicting that corn-ethanol greenhouse gas emissions relative to gasoline will improve 29 percent from 2005–2015.[4]

But believe it or not, these are still minor issues relative to the other fundamental conceptual problems plaguing LCA.

15. What are these other fundamental problems with sustainability standards based on LCA?

Even though we have already established two pretty good reasons for why sustainability standards for biofuel production make no sense (first, they focus on ethanol and not any other products from corn; and second, ethanol may replace coal instead of gasoline), LCA also assumes that the input used in ethanol production is replaced when we know it may only be *displaced*.

Let's take the use of energy inputs in the production of ethanol as an example. Suppose an ethanol plant uses electricity generated from natural gas. LCA assumes that the output that otherwise would have used natural gas (e.g., widgets) goes away or that the supply of natural gas just shows up because ethanol producers wanted it (no other industry would have used that natural gas). Well, just as it is a stretch to assume ethanol production replaces gasoline consumption, so too it is a stretch to assume ethanol replaces bourbon production.

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Some scientists measure the greenhouse gases emitted by laborers in ethanol production in Brazil. If ethanol does not use that labor, does it go away?

What may happen instead is that widgets, which used to use the "clean" energy of natural gas, now switch to the "dirty" energy of coal (coal emits much more greenhouse gases per unit of energy than does natural gas). Energy is energy—it is fungible. This is an elementary economic concept.

16. Is energy the only input that suffers from this fundamental error in logic?

No, all inputs used in ethanol production suffer from this problem.

Take labor, as an example. Some scientists measure the greenhouse gases emitted by laborers in ethanol production in Brazil. Again, if ethanol does not use that labor, does it go away? Are these people otherwise dead? A sustainability standard on ethanol may reduce the overall demand for labor and hence reduce the wage rate, potentially increasing the birthrate. It is at best ambiguous whether or not greenhouse gas emissions will decline.

Take land, as another example. The corn from land diverted to ethanol production is assumed to replace bourbon (or soybeans or wheat, etc.) production. But we know bourbon (or soybean or wheat) producers will seek land elsewhere, including from grasslands and forests (here in the United States and elsewhere, like in Brazil). Converting any kind of land from forest (and to a lesser extent, from grass) involves a huge amount of upfront CO_2 emissions (plus the cost of foregone annual sequestration of CO_2 of the land converted from forests). Like any other input, ethanol uses the "clean" land while bourbon uses "dirty" land converted from forests.

Accordingly, an LCA may not measure the actual greenhouse emissions from ethanol production. That's because the LCA is inevitably attributing a lower level of greenhouse emissions to ethanol production, because it is assumed that cropland is replaced—when it is, in fact, displaced. Given that the sustainability standard is on ethanol production, not bourbon production, ethanol producers circumvent the standard by choosing inputs with low greenhouse gas emissions, leaving more (cheaper) inputs with higher greenhouse gas emissions for other parties in nonregulated sectors. LCA measures are therefore misleading and may not measure the actual greenhouse gas emissions from ethanol production.

17. Is all bourbon production replaced?

No. Although it's true that ethanol consumption drives up the price of corn and thus drives down the demand for corn used in bourbon production, the demand for bourbon is not very price sensitive. Hence, corn growers for the most part will find land somewhere else to meet market demand.

18. To what extent does corn-ethanol production in the United States cause forests and grasslands to be converted to agricultural uses?

Timothy Searchinger, a research scholar at the Woodrow Wilson School at Princeton, led a research team that recently concluded that about 84 percent of the land used to grow corn for ethanol production in the United States is harnessed by displacing forests and grasslands in the United States and elsewhere.[5] Searchinger's findings are consistent with those from Purdue economists Thomas Hertel and Wallace Tyner, who arrive at a similar conclusion.[6]

There are two basic reasons why land use conversion does not follow ethanol production on a one-to-one basis. First, about 30 percent of the value of corn used in ethanol production is returned to the market in the form of by-products for animal feed. Second, because of the price increase in crops due to ethanol production, the demand for crops declines. But this may be partially offset if the yield per hectare for the land converted to crops displaced by corn-ethanol production is lower (more land is therefore needed to compensate for the lost production).

19. What do people who analyze indirect land use changes recommend?

Rather than using this to illustrate how bad a

concept LCA is, they instead recommend we extend LCA and include measures of the greenhouse gas emissions due to indirect land use changes.

20. What is wrong with that?

Well, what about other inputs and other *indirect use changes* (ethanol, for instance, may be replacing coal, not gasoline)? It is nearly impossible to measure all of this—you would need a gigantic linear programming model many times larger than those currently in use to calculate impact multipliers and to evaluate biofuel policies in all countries simultaneously. Just for land alone, it is difficult to determine how much land in the United States devoted to corn-ethanol is from converting forests versus taking land out of the conservation reserve program or increasing double-cropping of soybeans after wheat. Estimating the indirect land use effects in foreign countries is even more complex; for example, it would only take a 2 percent increase in cattle per hectare to accommodate total U.S. ethanol production in Brazil alone.[7] So it is difficult to determine how much land is converted from Amazon forests.

Even if we could somehow do all of this in a satisfactory manner, what would we do with the information? Regulating greenhouse gas emissions from ethanol to the exclusion of other products in the market is counterproductive. And regulating greenhouse gas emissions from ethanol consumed in the United States but not elsewhere is futile, and the chances of getting agreement at the national (let alone international) level would be slim.

21. So what should we do?

Simply stick to the basics and assume that ethanol, bourbon, and other corn products are net zero in CO_2 emissions. Forget about indirect use changes that may increase or decrease that number. If we are going to limit greenhouse gas emissions, the best option is to have a carbon tax on oil and natural gas at the refinery, coal at the plant using coal, and land at time of conversion into the production of biofuels, bourbon, shopping malls, etc. That covers all of the relevant sectors of the economy in a fair and efficient manner. There should be no emission tax on ethanol and bourbon production *per se*—let the market decide whether to embrace or reject ethanol given the appropriate input taxes. But if there is a rule on ethanol, a more stringent rule is required for bourbon—not the other way around as is currently the received wisdom.

22. But maybe a sustainability standard for ethanol is required because the government fails to tax CO_2 properly at the oil and natural gas refineries or at the coal plant (and fails to internalize externalities due to the production of corn in preventing 'dead zones' in the Mississippi river due to fertilizer runoff)?

But this means the U.S. government will therefore punish U.S. corn farmers and Brazilian ethanol producers to compensate for the U.S. government failing to have proper policies for other sectors! And it would let bourbon and cachaça off scot-free! Meanwhile, Brazil has very high taxes on oil and is doing far more than the United States to mitigate global warming. In response, the United States blocks ethanol imports because of a sustainability standard. This seems absurd.

23. But the United Kingdom has a fossil fuel tax seven times that of the United States, and Brazil has one five times as large. Aren't you double counting when using LCA for a sustainability standard when the tax has already been paid for the fossil fuel used in powering the tractor to grow the corn crop, manufacturing the corn into ethanol, and transporting the ethanol to the retail gasoline pump in these countries?

Exactly correct. A sustainability standard imposed on a product that has already paid a more than adequate fossil fuel tax in its production would certainly be double-counting and unfair, especially given the United States has arguably not properly taxed (from a greenhouse gas perspective) its fossil fuel inputs in the pro-

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duction of its ethanol. Even more perplexing is that the European Union has, California and other states are, and the United States might be implementing a cap-and-trade program. All fossil fuels used by electricity plants and other types of industries will have to buy permits to produce their product. It's a good question why anyone would "double count" ethanol production and not other products.

24. Although you keep saying to forget about LCA and indirect use changes and treat ethanol, bourbon, and all other products alike (leave them alone—just tax fossil fuels and land conversion if we're going to address greenhouse gas emissions), you do however seem to imply that maybe we should treat ethanol more favorably than all other products. Am I correct?

Yes, you are correct but only under one condition: if there is a suboptimal carbon tax on fossil fuels. If so, then an ethanol consumption mandate might be social-welfare improving, because, in order to pay for the higher ethanol price, consumers would be forced to pay a higher price for motor fuel and, thus, gasoline. The gasoline price increase would partially compensate for the suboptimal carbon tax.

But these social benefits have to be traded off with the social costs of increased ethanol production, which include increased pollution from corn production and other things.[8] Hence, this means of reducing greenhouse gas emissions is only recommended if there is nothing else politically possible. This is what we economists call "second-best" analysis. Ironically, the price of ethanol in this second-best world would likely be higher than ethanol prices in a world with an optimal carbon tax on fossil fuels.

25. Why an ethanol mandate and not an ethanol tax credit or import tariff, or a subsidy for corn and ethanol production? These are also policies now used for ethanol, am I not correct?

Yes, but all of these other policies actually make things worse if the optimal policies to deal with increased external costs are not put in place, as discussed below.

26. Are there any other reasons why sustainability standards are not helping the policy process in achieving our energy and environmental objectives?

Yes, unfortunately. The most important problem with LCA and sustainability standards is that analysts, policy makers, and the media are led to believe that if ethanol is found to reduce greenhouse gas emissions, then everything is fine. There is no discussion at all of the steep social costs imposed by the policies currently in place to promote U.S. ethanol production.

Take, for example, ethanol import tariffs. Because Brazil is so much more efficient than the United States in producing ethanol, the import tariff is costing billions of dollars per year in lost efficiency, especially in foregone greenhouse gas emission savings.[9] In fact, under some conditions, it is better to subsidize ethanol imports rather than domestic ethanol production.[10] Tax credits for ethanol consumption and production subsidies for corn and ethanol, ironically enough, increase total fuel consumption, which in turn leads to higher greenhouse gas emissions, worse traffic congestion, elevated air pollutants, and more fertilizer runoff than would have been the case in a world with a simple ethanol consumption mandate.[11] These production subsidies alone cost billions of dollars in inefficiency per year.[12] The annual inefficiency costs of just adding a tax credit to a mandate is in the order of $24–37 billion alone by the year 2022.[13] Furthermore, production subsidies for corn increase the inefficiency of biofuel policies and vice-versa. In fact, studies show U.S. ethanol production would have been zero in many years in the past without corn subsidies.[14]

27. So what you are saying is that the sustainability standard is at best, ineffective, and at worst, misleading, and meanwhile distracts attention from the real policy issues regarding ethanol?

Yes—and this is a travesty.

The most important problem with life-cycle accounting and sustainability standards is that people are led to believe that if ethanol is found to reduce greenhouse gas emissions, everything is fine.

28. Are there any issues regarding international trade law and biofuel sustainability standards?

There are several.[15] A sustainability standard means nonsustainable ethanol is treated less favorably than sustainable ethanol. This is problematic because the WTO prohibits members from discriminating between domestic and imported products based on the processes or production methods used to produce them. Imposing a higher tax on imported nonsustainable ethanol, as compared to a lower tax (because of the tax credit) on domestic sustainable ethanol blended with gasoline—a domestic-like product—would seem to violate General Agreement on Trade and Tariffs Article III(2)'s first sentence. The ethanol products, qua products, are the same, but they are taxed differently.

Privileged treatment for the blender's tax credit would probably also be discriminatory and violate GATT '94, Article I, if ethanol imported from at least one other country qualified for the tax credit. The U.S. would then be guilty of discriminating between like ethanol imported into the United States from two different countries, a violation of the most-favored nation principle of Article I.[16]

The biofuel sustainability mandate runs afoul of GATT Article XI, which prohibits all quantitative restrictions on imports. Because the mandate's sustainability criterion would seem to be an internal regulation that discriminates against unsustainable ethanol, it might seem to violate Article III(4)'s prohibition on discriminatory regulations. Since the regulation (the sustainability criterion attached to the mandate) regulates the process of making the ethanol and not the qualities of the ethanol itself, however, WTO decisions have indicated that the discrimination provisions of Article III(4) do not apply. Instead, because the sustainability criterion would operate to reduce the flow of unsustainable ethanol into the United States, it would constitute a quantitative restriction on unsustainable ethanol imports and, accordingly, violate Article XI.

Once an article of GATT is found to be violated (due to the sustainability-qualified discriminatory tax credit or the quantitative restriction inherent in the sustainability-qualified mandate), the United States would have to justify the policy by relying on the general exception (to conserve natural resources) found in Article XXg. Article XXg probably applies in principle because, although the ethanol production processes for imported ethanol occur in other countries, the resulting global warming consequences have a direct effect on the United States. However, the measure must also be shown to be consistent with the provisions found in the "chapeau" of Article XX. The latter would require that the U.S. measure not constitute arbitrary or unjustified discrimination against countries where the same conditions prevail and not constitute a disguised restriction on international trade. Under this approach, for example, the Appellate Body might consider the United States' sustainability criterion (applicable to the tax credit and the mandate) to be arbitrary or unjustified if it were imposed to disadvantage ethanol coming from a country that imposed a carbon tax or suite of fossil fuels taxes, either of which would reduce greenhouse gas emissions more in general, and from ethanol production in particular, than would a U.S. sustainability standard on ethanol.

The Appellate Body might also conclude that the discriminatory tax and restrictive mandate policies at issue are unnecessary means of achieving stated policy ends. Given that ethanol production from Brazil is more economically efficient and climate-friendly than ethanol production in the United States, removal of the U.S. corn subsidy and/or a reduction or elimination of the tariff on imported ethanol would mean the use of more Brazilian ethanol in the United States and, hence, a greater contribution to reducing greenhouse gas emissions than would otherwise be the case. These would be less-trade-restrictive measures, but they may be considered "additional" measures rather than substitute measures for a sustainability-conditioned mandate. Other discriminatory U.S. practices would also threaten to become an issue, such as the fact that the sustainability standard is written to allow compliance by domestic producers with-

The WTO prohibits members from discriminating between domestic and imported products based on the processes or production methods used to produce them.

out too much trouble and to grandfather in existing domestic producers who are not in compliance—but not existing foreign producers who are not in compliance.

29. Maybe some proponents of sustainability standards agree with you that current ethanol policy is an abomination, but there is little we can do about it politically. Hence, a sustainability standard is a way to counteract corn ethanol subsidies because they are predicated, in part, on the environmental benefits of expanded ethanol production. They cannot have it both ways—that is, receive subsidies and protection from international competition for being environmentally friendly while at the same time arguing against any evaluation on sustainability grounds.

Tying dubious sustainability standards to subsidies and import protection is exactly the tradeoff we do not want policymakers to make.

Well, this approach is rather Machiavellian,[17] which is okay once in a while—but it is likely to backfire in this case. People will think all is well once ethanol passes an analytically dubious and politically engineered sustainability test—a test, after all, that was written to ensure domestic compliance—so tying dubious sustainability standards to subsidies and import protection is exactly the tradeoff we do not want policymakers to make. Even so, the WTO is likely to strike it down regardless, so a sustainability standard is unlikely to constrain U.S. ethanol production.

We think it's best to face reality and leave LCA measures to physical scientists while we economists do what we do best: use welfare economics to analyze the costs and benefits of current policies that protect and subsidize ethanol production, and analyze policy alternatives that directly address the sources of greenhouse gas emissions.

This is going to be particularly important if the United States implements a national cap-and-trade program to reduce greenhouse gas emissions (the United States already has done this for nitrous oxides, and three regional cap-and-trade regimes for greenhouse gas emissions have either just begun or are beginning). LCA, and therefore a sustainability standard, will then be (or already is) redundant because total fossil fuel use will be capped. Only greenhouse gas emissions from domestic land conversion matter—why focus on indirect land use changes in the rest of the world when we ignore all types of international leakages for all products with a national cap-and-trade regime? Once the United States implements a cap-and-trade regime, emission leakage writ large will occur due to energy-intensive industries relocating to countries with lower emissions commitments and due to the reduction in world energy prices resulting in increased fossil fuel consumption elsewhere. Why not adjust the U.S. cap on greenhouse gas emissions for estimated total leakages? Why continue with a sustainability standard on one product (ethanol) and one input (land), when the same phenomena will occur for all products and all use changes (for all inputs and output) as well?

30. But if the government told you, "I do not care what you say, you have to develop for us an ethanol sustainability standard using LCA," what would you recommend?

We would simply argue that you have to use intertemporal cost-benefit analysis like global climate change economists do. In other words, think of ethanol production as an investment. The upfront investment costs are the CO_2 emissions from land converted from forests and grasslands into ethanol production. The annual costs are the foregone sequestration from the land that otherwise would have been forests, and the annual benefits are the net sequestration from ethanol production. To measure the latter, you would use the LCA measure without land-use effects or any other *indirect output or input-use changes*.

This would be a far more credible and genuinely sustainable standard, and is developed by de Gorter and Tsur.[18] To illustrate the properties of their test, de Gorter and Tsur use the same raw data as that used in Searchinger's study, they find that two land types in Brazil (grassland and cerrado) pass the sustainability standard for any social discount rate in the range considered by global climate change economists. On the other hand, no biofuel land

conversion in the United States passes their sustainability standard. The de Gorter– Tsur test is robust, comprehensive, and conservative, as it requires that the biofuel crop is produced on land previously not in crop production (i.e., converted land), thus avoiding controversy over how to measure indirect input use changes and direct impacts of biofuels on food prices.

But the de Gorter–Tsur analysis still does not answer the question: why compare corn ethanol to gasoline only? What about other uses of corn (and other crops using land?). That is an inherent problem with biofuel sustainability tests that cannot be overcome, and therefore, such standards are ultimately bogus from an economics point of view. The de Gorter–Tsur test certainly says nothing about all of the other ethanol policies that are imposing social costs, like production subsidies for ethanol and corn, import tariffs, and adding a tax credit to a mandate. Nor are they advocating the social benefits of a carbon tax (or cap-and-trade) on fossil fuels, which are the source of CO_2e emissions and oil dependency, while leaving ethanol (and bourbon) alone.

Notes

1. The greenhouse gases at issue are mainly CO_2, nitrous oxides and methane, expressed in CO_2 equivalent units and referred to as CO_2e. In this paper, we refer to CO_2e as "greenhouse gases."

2. Peter Mandelson, Commissioner of the EC, *The Guardian*, April 29, 2008.

3. The UNICA estimate comes from "GTAP," a gigantic programming model of the world economy. Marcos S. Jank and Joel Velasco, "UNICA Comments on California's Low Carbon Fuel Standard" (letter to Mary J. Nichols, chairman, California Air Resources Board, April 16, 2009).

4. (S&T)2 Consultants Inc., *An Examination of the Potential for Improving Carbon/Energy Balance of Bioethanol*, Report T39-TR1, International Energy Agency, 2009.

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15. This section benefited greatly from the input of John Barceló of the Cornell Law School.

16. Article I expressly includes the principles of Article III(2) (nondiscrimination in internal taxation) in the MFN concept so as to require nondiscrimination in internal taxation, as between products coming from different foreign countries.

17. It would fall into the same category as a Mothers Against Drunk Driving initiative favoring an ethanol tax credit to reduce consumption of bourbon.

18. Harry de Gorter and Yacov Tsur, "Towards a Genuine Sustainability Criterion for Biofuel Production."

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