U.S. Ethanol Mandate Is a Hidden Subsidy to Corn Producers

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Introduction

It is almost taken for granted that Ethanol mandate set by the United States government increases corn prices. In turn, over the past decade higher corn prices directly and indirectly have caused several issues such as increased overall consumer food prices, destruction of wet and grass lands, loss of wild life, air and water pollution, as well as increased producer costs in the industries like hog, poultry, beef, restaurant, and more. Whereas there are studies that show the impact of biofuel production on U.S. corn prices (Hausman et al. 2012) and then there are some studies that demonstrate that high corn prices cause the negative effect on environment and other industries (Roberts and Schlenker 2010 - food prices, Banse et al.2008, Hertel et al. 2010, Bullock and Couleau 2012), there are no studies that explicitly establish the link between these issues, corn prices and the mandate. This link is necessary in order to properly account for the effects of the mandate on the environment and other industries. To prove this relation, this study uses welfare economics framework to show that the US ethanol mandate is actually a hidden subsidy to corn producers, and not just in the U.S., but all over the world. In turn, this allows us to identify the role of the mandate in the consequent negative externalities it produces (at least partially) for the environment and other industries. The study is important because in order to find the effective solutions to these unintended negative effects going forward, the changes must come by addressing the roots of the all causing sources, and one of them is the Ethanol mandate policy itself.

The Disconnect

What has caused the disconnect between the mandate and its effects is that there are three policy instruments that have been in place almost simultaneously: biofuel subsidies, ethanol excise tax credits, which are both provided directly to the ethanol industry, and then there is an Ethanol mandate that targets the gasoline industry, but benefits the ethanol industry and corn producers. Since the first two instruments, biofuel subsidies and tax credits, are direct subsidies, previous literature readily addresses

their effects on agricultural markets, other industries, food prices, and environment (Rajagopal et al. 2007, Khana 2008, McPhail et al. 2008, Taheripour and Tyner 2008, de Gorter and Just 2009). However, the mandate is an indirect subsidy that requires a careful welfare treatment to identify it as a hidden subsidy to the corn producers first before cause and effect conclusions can be made, and this paper accomplishes just that.

Background: Corn Industry and the U.S. Energy Policies

Excise-tax credits for ethanol have been in place for a long time (Ando 2010), but the Energy Policy Act (EPA) that introduced a mandated blend of gasoline and ethanol was first passed by the U.S. Congress in 2005. It was presented to the public as an attempt to combat growing energy problems and it instituted the first Renewal Fuel Standards (RFS) program. The Act mandates 7.5 billion US gallons of Ethanol to be mixed with the gasoline sold by 2012. Two years later the Energy Independence and Security Act of 2007 (EISA 2007) extended the target to 36 billion US gallons by 2022. Food Conservation and Energy Act of 2008 (FCEA 2008) followed and included new incentives directly to the ethanol producers. The rationale behind these acts was in big part to reduce the greenhouse gases and CO2 emissions as well as to preserve resources, unfortunately, once controlled for the externalities, the post studies have shown that the results in many cases proved to be counter to the initial idea. Now to correct for these, the link to the ultimate foal is Already by the end of 2005 the United States became the largest ethanol producer in the world (EIA 2012). As of 2011 the U.S. ethanol production accounted for 50.1% that of the world, expanding production to 13,900 million gallons per year (USDA 2012). In the last three years on average 40% of corn produced went to ethanol production (USDA 2012). Ethanol content in gasoline expanded from 8 percent in 2009 to 10 percent in 2011 (EIA 2013).

Unintended Consequences of the Policies

The policies initiated by the EPA 2005 indirectly have caused several unintended consequences. First, the mandate caused increases in corn prices and in overall consumer food prices (Roberts and Schlenker 2010, Hausman et al. 2012); second, high prices incentivize farmers to expand corn acreage that

consequently causes destruction of wetlands, grassland, and forests (Fargione et al. 2008, Hertel et al. 2010); third, the destruction of these marginal lands cause loss of wildlife and releases of carbon (Searchinger et al. 2008); fourth, as a result of increased corn production fertilizer and pesticide runoffs also increased (Hertel et. al. 2010, Gorter and Just 2010); fifth, burning of ethanol as vehicle fuel releases benzene, which is considered a carcinogen (Ando 2010). This study's goal is provide a missing theoretical link between the mandate and the negative externalities.

Discussion and Contribution

A similar themed study was conducted by Schmitz et al. (2003) concluding that Brazilian government mandate for the blend ratio between alcohol and gasoline is a hidden subsidy for the Brazilian sugar industry. Likewise, using welfare analysis, this study establishes that the U.S. Ethanol mandate is a hidden subsidy to the corn producers; however, the study adds two nuances to the model. First, in contrast to the case of the Brazilian hidden subsidies which benefited only Brazilian farmers, the nuance of this paper is that the U.S. Ethanol mandate benefits not just the U.S. corn producers but corn producers all over the world, especially those that are close U.S. trading partners. For example, in response to the high corn prices Brazilian farmers expanded corn plantings in 2011-2012 ending up with a record high corn harvest and as of August 2012 Brazil has surpassed the U.S. as the top corn exporter for the first time in history (USDA 2013). Second, while in Brazilian case the subsidies were only production and not trade distorting, in the case of the US Ethanol mandate, the hidden subsidies are actually both production and trade distorting, which is another contribution to the model. For instance, and on January 30th, 2013, Walls Street Journal reported that the U.S. corn-ethanol industry called upon the Obama administration to reduce imports of ethanol from Brazil, in attempt to reduce competition and improve its profit margins (Tracy 2013).

What is intriguing about the overall model is that whereas under direct subsidies such as price supports and deficiency payments, world prices for a particular commodity usually decrease, under a hidden type of subsidy, such as the fuel blend mandates, world prices for the biofuel crop actually increase as has

already been seen in the Brazilian sugar case (Schmitz et al. 2003). This study reaches the same conclusion in case of corn under the U.S. Ethanol mandate. Schmitz et al. 2003 conclude even further that in some cases under hidden subsidies structure, even if world prices for corn decrease, the producers' welfare increases despite the lower prices. This study also considers such case accounting for the new adjustments to the model.

Theoretical Model

For domestic market in Figure 1 the aggregate total domestic demand curve for corn, D_T^1, is comprised of demand for corn as food, feed, and fuel for ethanol. In Figure 1 displays only demand due to corn-based fuel for ethanol, D_{fuel}^1 , while aggregate demand of corn due to food and animal feed is assumed as difference between D_T^1 and D_{fuel}^1 and defined as $D_{Other}^1 = D_T^1 - D_{fuel}^1$ (not shown on the graph). The aggregate supply of corn, S_c^1satisfies D_T^1 at equilibrium corn price, P_c^1, and quantity, Q_c^1, while q_{fuel}^1 corresponds to quantity at D_{fuel}^1, at prices P_c^1 under total S_c^1.

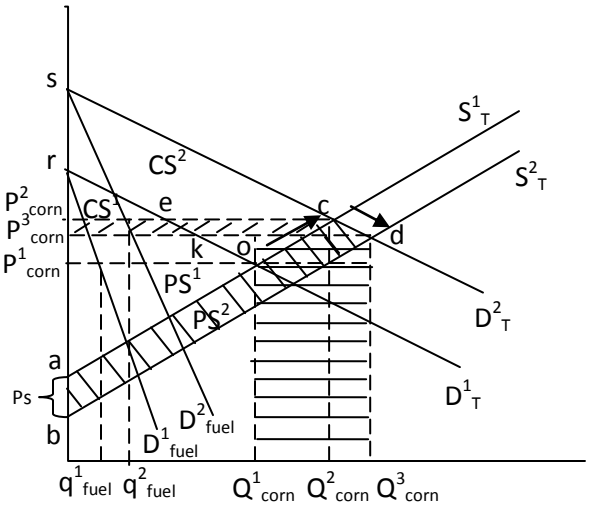


Figure 1. U.S. Ethanol Mandate Is a Subsidy to the U.S. Corn Producers

When a U.S. Ethanol mandate is introduced, it shifts demand for corn due to fuel upwards to D_{fuel}^2, thus also increasing total demand for corn in the U.S. shifting it upwards as well to D_T^2 , (even if the demand due to food and animal feed remains the same). Under new demands, quantity of corn due to fuel and

total quantity also increase to q^2_{fuel} and Q^2_c, which in turn raises price of corn to P^2_c. Next, assuming that farmers are risk averse, the policy of the Ethanol mandate grants them certainty in the firmness of the demand, this allows producers extend the supply outward to S^2_c according to Just, Hueth and Schmitz (1982). The new and final quantity supplied is Q^3_c which is substantially higher than Q^2_c, however, eventually as shown by Ando (2010) new consumer demand, D^3_T, grows around the excess supply the price settles at P^2_c. Both consumer and producer surpluses increases: consumer welfare as a result of change is surplus is $P^2_{corn}db$- $P^1_{corn}oa$, while producer welfare as a result of change in surplus is $P^2_{corn}sd$- $P^1_{corn}or$. The distance *ab* is equal to the hidden subsidy, which price is P^{US}_s, created by the U.S. – which finally proves the mandate as the hidden subsidy.

In addition, as Schmitz et al. (2003) shows that even if sugar price decreases, due to the mandates the producers still receive a hidden subsidy, similarly we prove that if the U.S. Ethanol mandate is in place, it generates a hidden subsidy for corn producers even if price of corn goes down (Figure 2). Consumer welfare as a result of change is surplus is $P^1_{corn}db$- $P^2_{corn}oa$, while producer welfare as a result of change in surplus is $P^1_{corn}sd$-$P^2_{corn}or$. It can be seen that whereas consumer's surplus may not always be positive in cases of some demand elasticities, the producer's welfare is always positive.

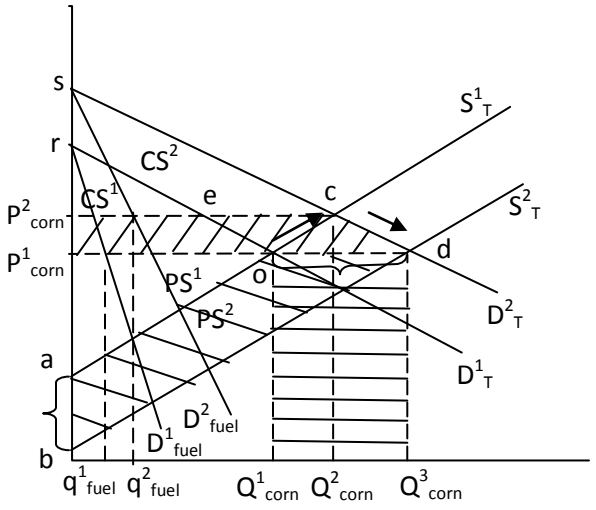


Figure 2. U.S. Ethanol Mandate Is a Subsidy to the U.S. Corn Producers even if Corn Price Goes Down

Next, we extend the model to a world model that depicts two markets, U.S. domestic and that of the rest of the world (ROW). The model shows how U.S. Ethanol mandate is a hidden subsidy to foreign corn producers in addition to the ones in the U.S. Figure 3 depicts the domestic and foreign (or ROW) corn markets as perceived by the U.S. in the left- and right-hand side panels, respectively.

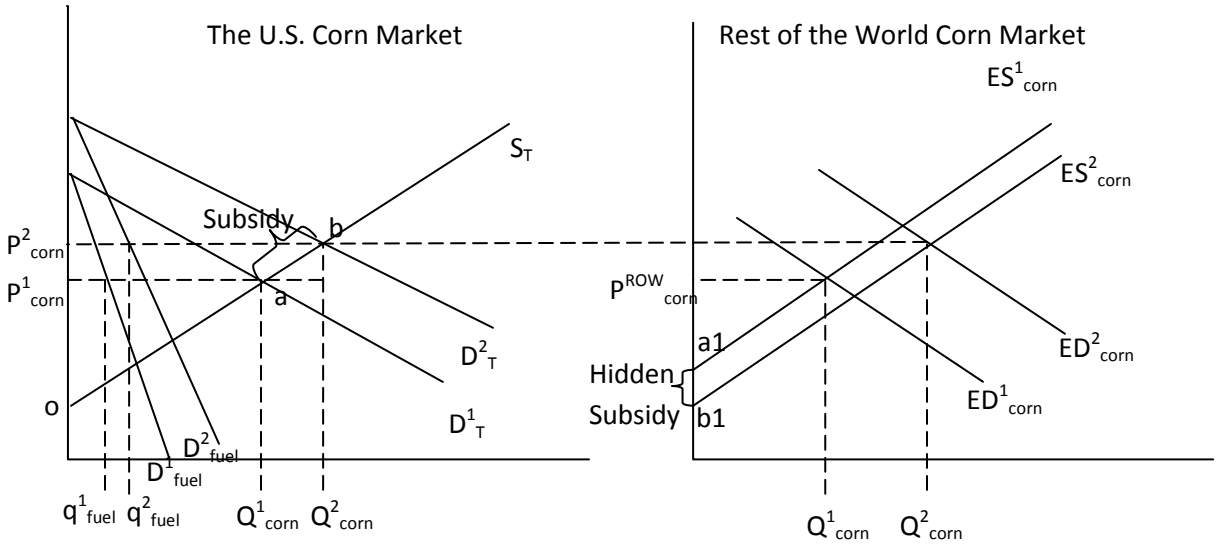


Figure 3. World Corn Markets

The definitions for the U.S. market remain the same as in Figure 1, except for a few changes that allowed us to compress the model for convenience. S_T now represents a total corn supply and *ab*, similarly to that of Firugure 1, is still the interval that demonstrates the price of the hidden subsidy. In this Figure 3, however, the supply changes are demonstrated by diagonal movement on the total supply curve, S_T. In the meantime, in the right-hand side panel, in the absence of the mandate, ROW market has its equilibrium at quantity of corn produced at Q^1_{corn} and at corn price, P^{ROW}_{corn}, and corresponding the initial excess supply curve ES^1_{corn} and the excess demand curve ED^1_{corn} are displayed in the right-hand side panel of Figure 3. Now when the mandate is introduced by the U.S., which raises the U.S. demand for corn to D^2_T at price levels P^2_{corn}as depicted in the left-hand side panel, such high price compared to that of rest of the world, incentivizes farmers in ROW to increase production to Q^2_{corn}, thus increasing excess supply of ROW to ES^1_c, by shifting it out to the right. Thus, corn producers in ROW (or specific country

like Brazil, for example) receive subsidies, *a1b1*, hidden in the elevated levels of corn price caused by the mandate.

The model's framework also demonstrates that in contrast to Brazillian case covered in Schmitz et al. 2003, the U.S. Ethanol subsidies are not only production but also trade distorting. Figure 4 demonstrates how under the mandate that ends up as a hidden subsidy to the corn producers, the trade rectangle (*T*') has increased over the previous trade activity (*T*). It can be seen that the increased excess demand *ED'* on the side of the U.S. caused increased prices for corn, *P'*. The excess supply of the ROW has expanded at least in part to facilitate new stable demand out of the U.S.

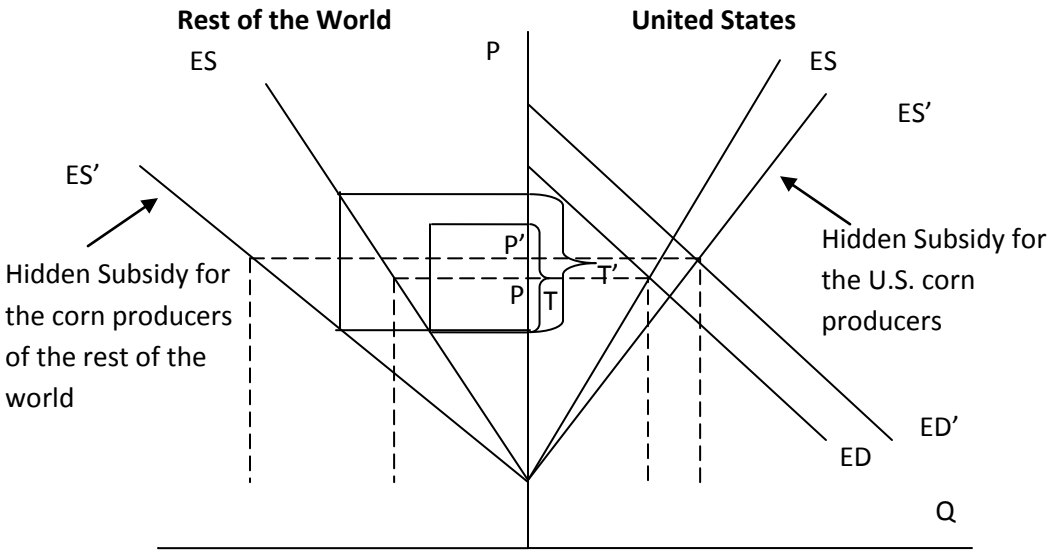


Figure 4. Corn Production and Trade Distorting Subsidy

This concludes the theoretical proof that the U.S. Ethanol mandate is a hidden subsidy to the corn producers in the U.S. as well as rest of the world, especially in the U.S. trade partner countries. The shortcoming of the models shown is that the models are not dynamic frameworks. It is also very important to incorporate environmental costs in a welfare analysis, but of the purposes of this paper they were not necessary.. Although the benefit of these theoretical models is that they allow to integrate the

environmental factors such as cost and damages in order the compute the comprehensive welfare measures. Specifically, what this paper will do in addition to the unique model already in place is try to model a corn and ethanol markets together. This way the environmental costs that are specific to each industry can be accounted for in the welfare analysis. The analysis will also delve into presenting not just the U.S model and then the U.S. and ROW one. Addressing these concerns would be another study in itself since the priority of this study is to tie the mandate to the environmental consequences, many of which were already studies. Ours was the job of bridging one to the other. One of the benefits of the methodology is that despite the complexity of the corn market (three components), it was possible to single out the demand of corn that wad due to the demand for fuel, this allowed us to avoid the effect of the other two instruments that were directed to the ethanol industry and that of corn.

Data

The data for this study are obtained from several sources. The data span the years 1980-2012. Yearly ethanol prices, produced quantities, and yields per ha come from the U.S. Bioenergy Statistics database. Yearly corn and ethanol world trade data were obtained from the database of Foreign Agricultural Trade of the United States (FATUS) of Foreign Agricultural Service (FAS 2013). The U.S. and Brazil's yearly corn production, consumption, imports, exports, farm and market prices are taken from the Feed Grains Database provided by Economic Research Service at USDA (ERS 2013). The percentage of ethanol in retail gasoline for the years 2005-2012 were obtained from Energy Information Administration (EIA) Monthly Energy Review (EIA 2012). The uniqueness of the data and chosen time is that this period is infused with parallels between the U.S and Brazillian Ethanol mandates, both being a hidden subsidy in nature. Also, the region of North America is very strategic when it comes to corn since U.S. and Brazil are the largest ethanol producers. Although it might seem that the challenges that this data might bring into the methodology is the endogeneity; however, in welfare economics framework it is not an issue as it is in the econometrical ones (Hausman, Auffhammer and Berck 2012). Next, when the model considers the rest of the world (ROW), small and big countries are not distinguished in that right hand side panel,

however, as it is known from classic economic literature supply and prices are adopted differently. However, the given methodology was developed to establish the theoretical link between the mandate and its impacts, having establish this connection all studies that were already written about particular countries or region create a direct link to the causing sources including that the Ethanol mandate. Once the empirical data is put thorough the model, we expected for the hidden subsidy to emerge in the *ab* distance. We expect the mandate to have quite a substantial impact as a hidden subsidy on corn farmers within the U.S. and abroad. Thirdly, the data will point to exact trade distorting effect.

References

Ando, A.W., M. Khanna, F. Taheripour. 2010. "Market and Social Welfare Effects of the Renewable Fuels Standard," in M. Khanna, J. Scheffran, D. Zilberman (Eds), *Handbook of Bioenergy Economics and Policy*, Chapter 14, New York: Springer.

Bullock, D. S. and Couleau, A. 2012. The U.S. Ethanol and Commodity Policy Labyrinth: Looking into Welfare Space to Analyze Policies that Combine Multiple Instruments. 2012 Conference, August 18-24, 2012, Foz do Iguacu, Brazil, International Association of Agricultural Economists.

Chen, X., H. Huang, and M. Khanna. 2012 "Land Use and Greenhouse Gas implications of Biofuels: Role of Technology and Policy." Available at SSRN: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2001520\

Corn Crop, 2010/11 and 2011/12: USDA, World Agricultural Supply and Demand Estimates, August 10, 2012, page 12, http://usda01.library.cornell.edu/usda/waob/wasde//2010s/2012/wasde-08-10-2012.pdf. Accessed on 02/17/2013.

Corn Use for Ethanol Production: Energy Information Administration, *Monthly Energy Review*, August 2012, http://www.eia.gov/totalenergy/data/monthly/query/mer_data_excel.asp?table=T10.03. Accessed on 02/17/2013.

Fargione, J., J. Hill, D. Tilman, S. Polasky and P. Hawthorne. 2008. "Land Clearing and the Biofuel Carbon Debt," *Science* 319: 1235-1238.

Gorter, de H and D. Just. 2010. "The Social Costs and Benefits of Biofuels: The Intersection of Environmental, Energy and Agricultural Policy," *Applied Economic Perspectives and Policy*, **32**, (1), 4-32.

Hausman (Almirall), C., M. Auffhammer, and P Berck. 2012. "Farm Acreage Shocks and Food Prices: An
SVAR Approach to Understanding the Impacts of Biofuels," forthcoming in *Environmental and Resource Economics*, Available at SSRN: http://ssrn.com/abstract=1605507.
Hamelinck, C.N, A.P.C Faaij. 2006. "Outlook for advanced biofuels," *Energy Policy*, **34**, (17), 3268-3283.

Hertel, T.W., W.E. Tyner, and D.K. Birur. 2010. "The Global Impacts of Biofuel Mandates." *The Energy Journal* 31(1):75-100.

Khanna, M. 2008. "Cellulosic Biofuels: Are They Economically Viable and Environmentally Sustainable?" *Choices,* 3rd Quarter, **23**(3).

New York Times. 2008. *U.N. Says Biofuels Subsidy Raise Food Bill and Hunger*, Oct. 7, 2008.

Rajagopal, D. and D. Zilberman. 2007. "Review of Environmental, Economic, and Policy Aspects of Biofuels," World Bank, Policy Research Working Paper 4341.

Reilly, J. and S. Paltsev. 2009. "Biomass Energy and Competition for Land," in T.W. Hertel, S. Rose and R.S.J. Tol (Eds): *Economic Analysis of Land-Use in Global Climate Change Policy*. Chapter 8. Routledge.

Roberts, M. and W. Schlenker. 2010. "The U.S. Biofuel Mandate and World Food Prices: An Econometric
Analysis of the Demand and Supply of Calories." NBER Working Paper N°15921, National Bureau of Economic Research, Inc.

Rosegrant, M.W., M.S. Paisner, S. Meijer and J. Witcover. 2001. *Global Food Projections to 2020: Emerging Trends and Alternative Futures*, International Food Policy Research Institute, Washington DC.

Rosegrant, M.W, T. Zhu, S. Msangi, T. Sulser. 2008. "Global Scenarios for Biofuels. Impacts and Implications," *Review of Agricultural Economics*, **30**(3), 495-505.

Renewable Fuels Association (2012-03-06). "Acelerating Industry Innovation - 2012 Ethanol Industry Outlook". Renewable Fuels Association. Retrieved on 02/17/2013.

The Economist. 2010. *Brazil's agricultural miracle: How to feed the world*. 26th August 2010. http://www.economist.com/node/16889019?story_id=16889019
The Economist. 2012. *Brazilian brew: America opens up to Brazilian ethanol*. 7th January 2012.

Searchinger, T., R. Heimlich, R.A. Houghton, F. Dong, A. Elobeid, J. Fabiosa, S. Tokgoz, D. Hayes and T-H. Yu. 2008. "Use of U.S. Croplands for Biofuels Increases Greenhouse Gases through Emissions from Land-Use Change," *Science* **319**, 1238-1240.

Proponents: Schneider, U.A. and B.A. McCarl. 2003. "Economic Potential of Biomass Based Fuels for Greenhouse Gas Emission Mitigation," *Environmental and Resource Economics* **24**(4), 291-312.
Energy Information Administration (EIA) 2012. Biofuels Issues and Trends. http://www.eia.gov/biofuels/issuestrends/pdf/bit.pdf. Accessed on 02/17/2013.

FAS 2013. Grain: World Markets and Trade http://www.fas.usda.gov/psdonline/circulars/grain.pdf. Accessed on 02/18/2013.

McPhail, Lihong Lu and Bruce Alan Babcock. Short-Run Price and Welfare Impacts of Federal Ethanol Policies. 2008. *Center for Agricultural and Rural Development (CARD) Publications*, Center for Agricultural and Rural Development (CARD) at Iowa State University.

Schmitz, A., Schmitz, T. G., and Seale, J. L., Jr., 2003. "Ethanol from Sugar: The Case of Hidden Sugar Subsidies in Brazil," Policy Briefs 15679, University of Florida, International Agricultural Trade and Policy Center.

Schmitz, A., Moss, C.B., Schmitz, T.G. 2007. Ethanol: No Free Lunch. *Journal of Agricultural & Food Industrial Organization*, 2007, vol. 5, issue 2: 3.

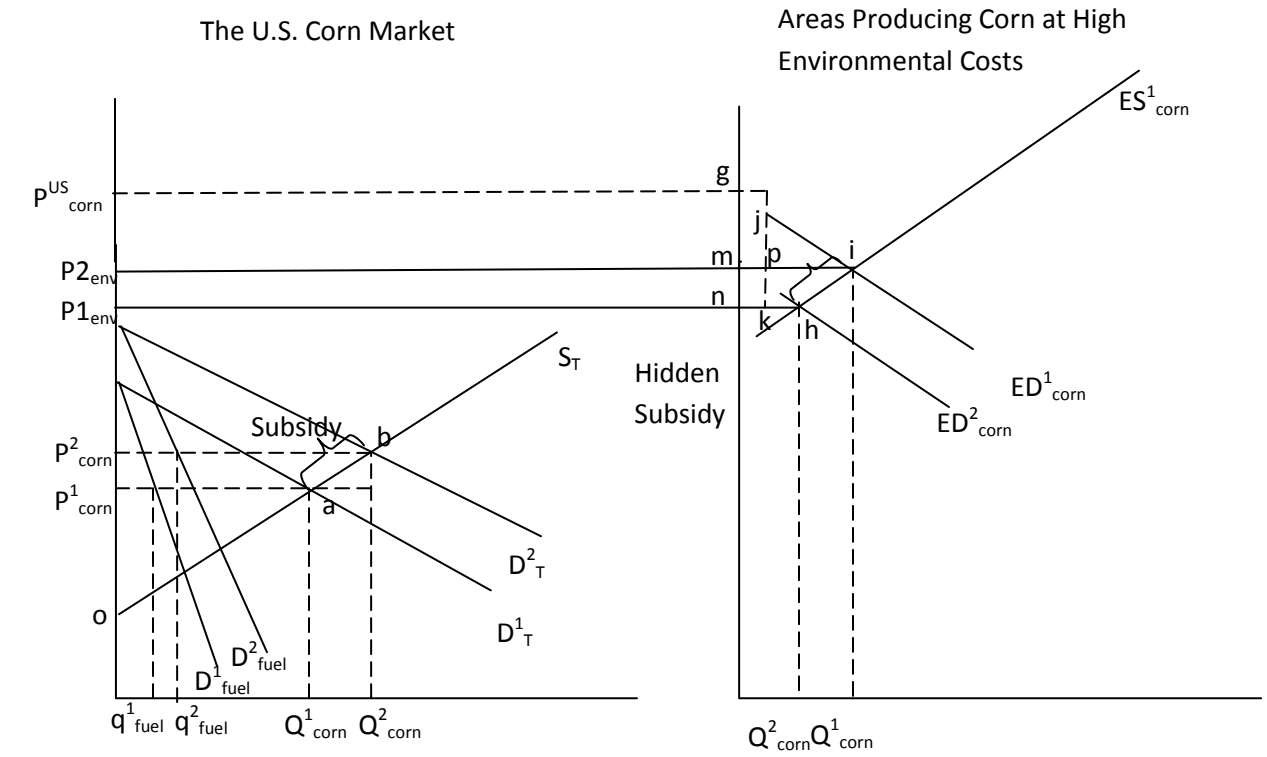
USDA, 2012. National Agricultural Statistics Service, Crop Progress. http://usda01.library.cornell.edu/usda/nass/CropProg//2010s/2012/CropProg-07-30-2012.pdf. Accessed on 02/18/2013.

USDA, Foreign Agricultural Service, *Brazil Biofuels 2011*: 2. http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Sao%20Paulo%20ATO_Brazil_7-27-2011.pdf. Accessed on 02/17/2013.

USDA Foreign Agriculture Service, *Brazil Biofuels 2012*: 3-8. http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Sao%20Paulo%20ATO_Brazil_8-21-2012.pdf. Accessed on 02/17/2013.

USDA, National Agricultural Statistics Service, Crop Production, September 12, 2012, http://usda01.library.cornell.edu/usda/current/CropProd/CropProd-09-12-2012.pdf. Accessed on 02/17/2013.

Appendix.


The U.S. Corn Market
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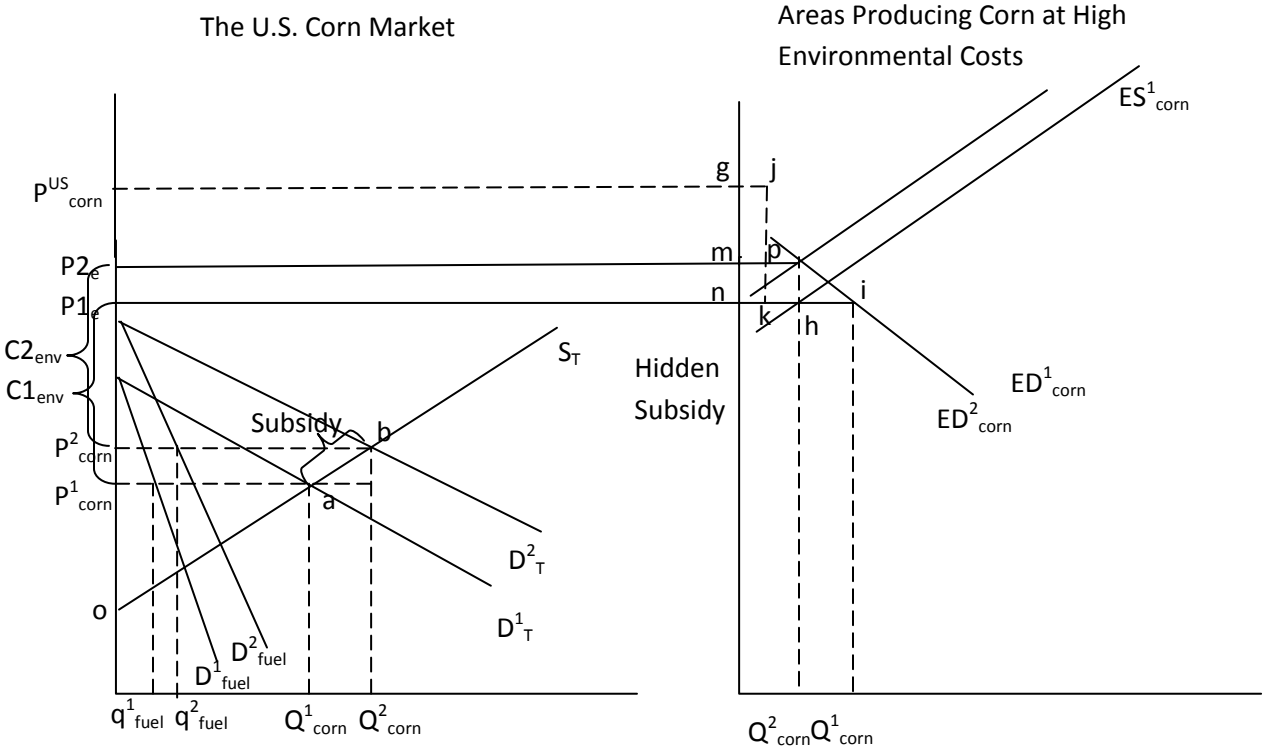
The U.S. Corn Market
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