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# Brazilian Ethanol and U.S. Industrial Organization: An Analysis of Bilateral Trade Barrier Removal

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# Abstract:

With rising petroleum costs and a plethora of other influences causing international ethanol demand to grow at an unprecedented rate, discussion of trade liberalization has become an important point of debate for the ethanol production industry. Although there have been many studies on the results of the removal of trade barriers there has been little emphasis on the potential impact it would have on domestic industrial organization. This paper looks to analyze the possible effects of ethanol trade barrier removal between Brazil and the United States on U.S. industrial organization through evaluation of the removal's influence on incentives for consolidation in both farmer and non-farmer owned sectors of the U.S. ethanol production industry. Both the existing deadweight loss due to the accumulation of trade barrier costs and the potential for costs associated with increased market concentration are compared in the evaluation process as well as evaluation and incorporation of theory on trade flows and market structure resulting from trade tariff removal.

# I. Introduction

It is uncertain whether or not when Henry Ford described ethanol as "the fuel of the future[1]" he had such a distant future in mind. For nearly a century, oil has dominated transport fuel markets as the primary automotive energy source. However, metaphorically speaking, the stars have aligned for the ethanol production industry. Predictions that world oil reserves are approaching exhaustion combined with increasing concern over rising international crude oil prices, greenhouse gas emissions, global warming, energy independence, and other important factors have caused an unprecedented boom in global ethanol production and trade. With such rapid increases in the international trade of ethanol, hastily constructed trade agreements and domestic and international trade practices/policy are shaping the industrial structure of this still emerging global industry. It is estimated that tariffs onethanol trade between the United States and Brazil have already cost nearly 80 million dollars in social deadweight loss[2]. For this reason a rather large and influential group of political leaders and economists, headed by Jeb Bush the co-chairmen of the Interamerican Ethanol Commission, are advocating the removal of barriers currently designed to promote and protect domestic production[3]. This paper looks to analyze the possible effects of ethanol trade tariff removal between Brazil and the United States on U.S. industrial organization through evaluation of the resulting increase of incentives for

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[1] William Lemos, "The Brazilian Model" *JCIS Chemical Business Americas* 271 no. 5 (2007), http://www.icis.com/publications.

[2] Ariadna Martinex-Gonzalez, Ian M. Sheldon, and Stanley Thompson, "Estimating the Welfare Effects of U.S. Distortions in the Ethanol Market Using a Partial Equilibrium Trade Model" *Journal of Agriculture and Food Industrial Organization* 5 (2007): 227-42.

[3] Interamerican Ethanol Commission, "Leadership" Interamerican Ethanol Commission, http://helpfuelthefuture.org/web/content/view/41/54/

consolidation in both farmer and non-farmer owned sectors of the U.S. ethanol production industry.

## II. Background

In the timeline for automotive transportation, ethanol is even older than the Model T. It has been produced and consumed in the United States and Brazil throughout the past century. Ethanol was first used as a transport fuel in the U.S. around 1908 and its mass production continued into the late 1930's at which time a plant in Atchison, Kansas was producing nearly 18 million gallons of ethanol per year for over two thousand service stations across the Midwestern United States[4]. However, after World War II petroleum based alternatives became available in mass and at low costs taking over the international markets for transport fuel. Interest in U.S. ethanol production did not resurface until 1978 when the first tax exemptions were passed for gasoline blended with 10% ethanol[5].

Even during ethanol's global decline in the 1940's Brazil has been a significant outlier in the global trend away from ethanol and towards its petroleum based substitute, gasoline. In Brazil a 5% blending of anhydrous ethanol into the nation's gasoline was first approved in 1931 and then made mandatory in 1938[6]. Ethanol became recognized as more than just an additive in the early 1970's when Brazilian spending on foreign crude oil quadrupled. With such an increase in spending ethanol began to be seen as a serious alternative to crude oil[7]. Government officials

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[4] William Lemos, "The Brazilian Model" *JCIS Chemical Business Americas* 271 no. 5 (2007), http://www.icis.com/publications.

[5] Joseph Dipardo. "Outlook for Biomass Ethanol Production and Demand:. *Energy Information Administration.* (2001): 1-14. <www.eia.doe.gov/oiaf/analysispaper/biomass.html >.

[6] Masami Kojima and Todd Johnson. "Potential for Biofuels for Transportation in Developing Countries" World Banke Energy and Water Department, http://www.esmap.org/filez/pubs/31205BifuelsforWeb.pdf.

[7] William Lemos, "The Brazilian Model" *JCIS Chemical Business Americas* 271 no. 5 (2007), http://www.icis.com/publications

foresaw the need for better domestic availability of ethanol and by 1975 Brazil initiated Proalcool, a forceful program of incentives for domestic ethanol production. With the help of Proalcool subsidies, Brazilian ethanol production quickly rose from 158 million to approximately 900 million gallons per year in 1978. Ethanol production continued to grow when in 1979 another oil crisis hit Brazil causing the price of crude oil to more than triple. As energy independence became an even more important goal for Brazil even car manufactures joined the ethanol revolution. By 1986 76% of Brazil's new cars were made with modified ethanol engines and domestic ethanol production reached 3.5 billion gallons[8]. This far surpassed U.S. production at this time which was still only 710 million gallons, making Brazil the pioneer of large scale ethanol production[9].

Brazil's ethanol production and consumption slipped in the late 1980's and early 1990's as the domestic subsidies provided by Proalcool were greatly reduced. This removal of subsidies triggered reduction in ethanol supply resulting in an ethanol shortage that shook consumer confidence. A reduction in ethanol consumption soon followed and by 1990 the proportion of new cars produced with ethanol engines dropped to 11%[10]. However, nearly a decade later the introduction of the flex fuel automobile, a vehicle with an engine capable of running on both ethanol and gasoline along with, once again, rising oil prices increased international interest in alternative energy sources causing Brazil's domestic ethanol production to resurge. By 2006 Brazilian production rose to roughly 4.5 billion gallons per year and is predicted to reach as high

[8]William Lemos, "The Brazilian Model" *JCIS Chemical Business Americas* 271 no. 5 (2007), http://www.icis.com/publications.
[9]Renewable Fuels Association, "Industry Statistics" The Renewable Fuels Association, http://www.ethanolrfa.org/industry/statistics/.
[10] William Lemos, "The Brazilian Model" *JCIS Chemical Business Americas* 271 no. 5 (2007), http://www.icis.com/publications.

as 9 billion gallons per year by 2013[11]. However, even with a head start and historically high levels of domestic support for ethanol production, Brazil is currently only the second largest producer of ethanol in the world.

The United States is the world's largest producer of ethanol and like Brazil is experiencing record expansion in the industry. U.S. ethanol production has increased dramatically in recent years. Currently, the U.S. produces roughly 7.2 billion gallons of ethanol per year with another 6.2 billion gallons of yearly production capacity under construction[12]. However, even though Brazil and the United States are industry leaders and unrivaled in their ethanol production abilities, thus far both countries still employ protectionist policies designed to shelter their domestic ethanol production industries. This protection is achieved by virtually prohibiting ethanol trade between the two countries with steep import tariffs[13].

Discussion of ethanol trade between the U.S. and Brazil begins with its production process and use of feedstock, or the biomass from which the ethanol is produced. Much like the process used to make moonshine, the production of Ethanol is a microbial conversion of biomass or feedstock such as corn or sugarcane into alcohol[14]. Although ethanol can be produced from sugars found in a variety of different plant biomasses, in Brazil and the United States it is produced almost exclusively from corn or sugarcane. First, the biomass is converted into sugars, which are fermented. After this fermentation process water is removed from the product creating the substance known as anhydrous ethanol. In the final step anhydrous ethanol is denatured, a

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[11]William Lemos, "The Brazilian Model" *JCIS Chemical Business Americas* 271 no. 5 (2007), http://www.icis.com/publications.

[12] Renewable Fuels Association, "Industry Statistics" The Renewable Fuels Association, http://www.ethanolrfa.org/industry/statistics/.

[13] David Sandalow, Freedom From Oil: How the Next President Can End the United States' Oil Addictiion. (New York: McGraw-Hill, 2008), 189-205.

[14]Moreira, Jose R. and Goldember, Jose. "The Alcohol Program," *Energy Policy* (1999) 229-245

blending process that makes ethanol unfit for human consumption by adding amounts of substances like gasoline[15].

Generally, producers of anhydrous ethanol do not blend their own ethanol, this is done by an industry of blenders or refiners separate from the initial production process. Because anhydrous ethanol produced from any feedstock is essentially the same product it is assumed to be homogenous or a non-differentiable good. This means that ethanol blenders can purchase anhydrous ethanol without regard for its source-biomass[16]. This study will focus only on Brazilian ethanol made from sugarcane and U.S. ethanol produced from corn assuming the quantities of ethanol produced from other feedstock to be insignificant in relation to U.S. Brazilian trade and its effects on industrial organization.

Ethanol produced from sugarcane is far less expensive to produce than ethanol produced from corn. However, transportation costs limit sugarcane's use in the United States, a country that for the most part lacks the tropical climate and rainfall necessary for mass sugarcane production. Additionally, because all ethanol is part of a weight losing production process the most efficient structure for ethanol production will result in an industrial organization where ethanol production facilities are located in relatively close proximity to the areas where their specific feedstock is produced[17]. For this reason the U.S. is limited to the production of corn-based ethanol and Brazil, having the ability to produce sugarcane, may use this feedstock as a more efficient source of ethanol production. Once the original feedstock is transformed into anhydrous ethanol, it is, as was mentioned, a homogenous product[18].

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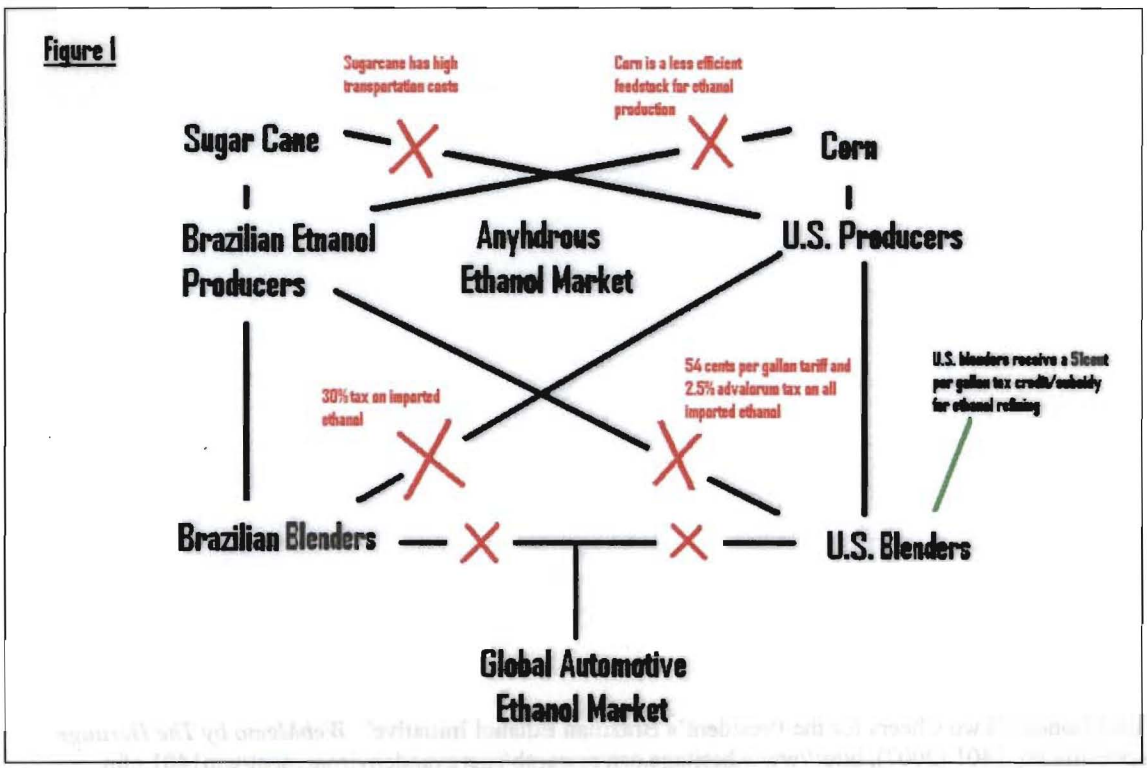
[15] Masami Kojima and Todd Johnson. "Potential for Biofuels for Transportation in Developing Countries" World Banke Energy and Water Department, http://www.esmap.org/filez/pubs/31205BifuelsforWeb.pdf.
[16] David Sandalow, *Freedom From Oil: How the Next President Can End the United States' Oil Addictiion.* (New York: McGraw-Hill, 2008), 197
[17] Moreira, Jose R. and Goldember, Jose. "The Alcohol Program," *Energy Policy* (1999) 229-245
[18] David Sandalow, Freedom From Oil: How the Next President Can End the United States' Oil Addictiion. (New York: McGraw-Hill, 2008), 189-205.

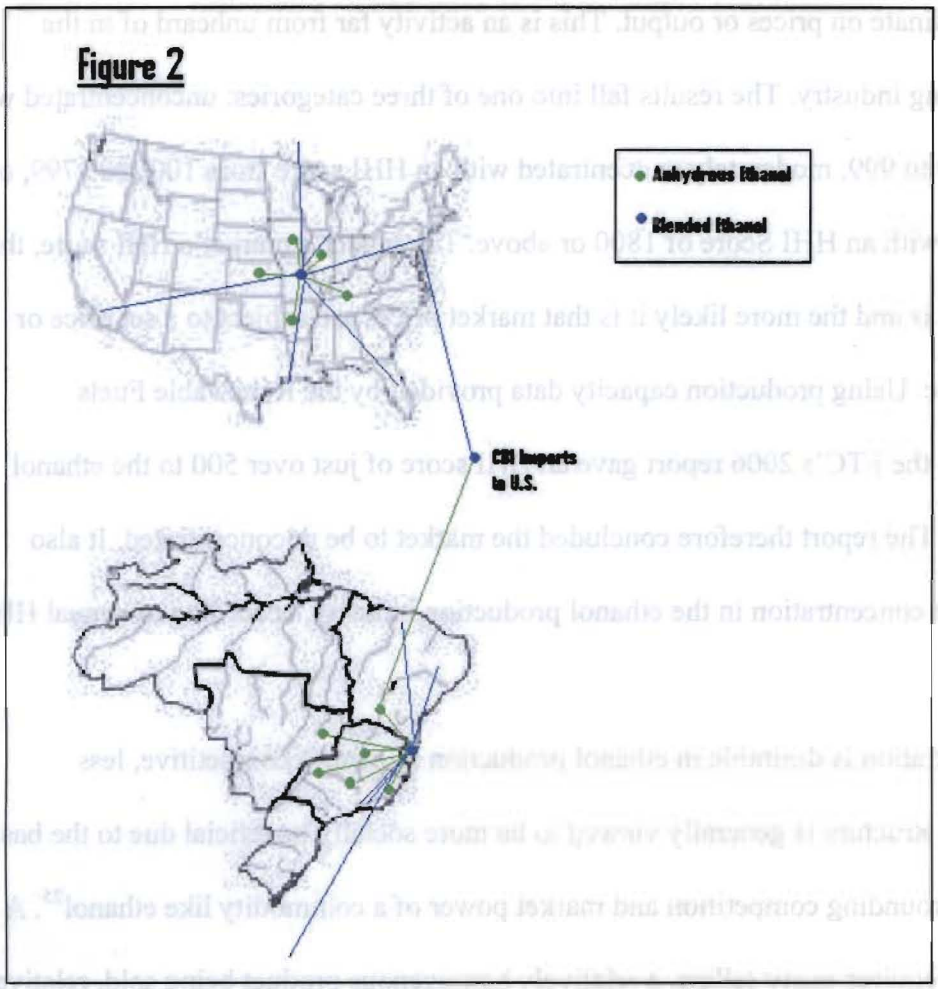
Both the United States and Brazil currently restrict the trade of both anhydrous and blended ethanol. Brazil protects its domestic production industry with a tax of roughly 30% on all imported ethanol. The United States imposes a 54 cents per gallon and 2.5% advalorum tax or tariff on all imported ethanol. The United States also offers a 51 cents per gallon production subsidy by way of tax credit to the ethanol blenders in order to account for the comparative advantage Brazilian producers of anhydrous ethanol obtain from the use of sugarcane as a more efficient feedstock. The tariffs, applied to both anhydrous and blended ethanol, effectively prevent ethanol trade between the U.S. and Brazil creating a situation in which both countries only produce ethanol for domestic consumption and for export to countries without significant import tariffs on ethanol[19]. This closed structure can be viewed in *Figure 1*.




[19] David Sandalow, *Freedom From Oil: How the Next President Can End the United States' Oil Addictiion.* (New York: McGraw-Hill, 2008), 195.

Therefore, in presence of trade tariffs, ethanol trade between the U.S. and Brazil is virtually nonexistent. This is depicted in the simplified trade flow diagram of *Figure 2*. The exception to this prevention of exchange is a small exemption in international policy. Under provisions in the Caribbean Basin Initiative (CBI) member states are able to export ethanol made from at least 50% U.S. produced feedstock to the United States free from duty[20]. Because of this policy, Jamaica is now the second largest importer of ethanol into the United States with other CBI countries following close behind[21]. However, in reality this imported ethanol is not a product of Jamaica. Instead, the policy allows for the importation of Brazilian ethanol through countries like Jamaica. The amount imported is a rather small. In 2006 sixty million gallons, only about 7% of the United States' domestic production, entered the country duty free through CBI provisions[22].

[20] Ariel Cohen, "Two Cheers for the President's Brazilian Ethanol Initiative" *WebMemo by The Heritage Foundation* no. 1401 (2007), http://www.heritage.org/research/energyandenvironement/wm1401.cfm.
[21] Renewable Fuels Association, "Industry Statistics" The Renewable Fuels Association, http://www.ethanolrfa.org/industry/statistics/.
[22] Ariel Cohen, "Two Cheers for the President's Brazilian Ethanol Initiative" *WebMemo by The Heritage Foundation* no. 1401 (2007), http://www.heritage.org/research/energyandenvironement/wm1401.cfm.




Under this relatively closed trade status of industry protection, growth in U.S. ethanol production has developed into an internally competitive domestic production industry. Approximately 140 firms of various sizes are producing anhydrous ethanol across the United States[23]. The Federal Trade Commission or FTC, confirmed this internal competitiveness in its report on the market concentration of the U.S. ethanol production industry. Market Concentration is measured by the Herfindahl-Hirschman Indices (HHI). This process looks to define whether or not a single firm or small group of firms could wield sufficient market power

[23]Renewable Fuels Association, "Industry Statistics" The Renewable Fuels Association, http://www.ethanolrfa.org/industry/statistics/.

to set prices or coordinate on prices or output. This is an activity far from unheard of in the agricultural processing industry. The results fall into one of three categories: unconcentrated with an HHI score from 0 to 999, moderately concentrated with an HHI score from 1000 to 1799, or highly concentrated with an HHI Score of 1800 or above. The higher a market's HHI score, the more concentrated it is and the more likely it is that market prices are subject to a set price or coordinated influence. Using production capacity data provided by the Renewable Fuels Association or RFA, the FTC's 2006 report gave an HHI score of just over 500 to the ethanol production industry. The report therefore concluded the market to be unconcentrated. It also indicated that market concentration in the ethanol production industry, according to annual HHI scores, has been falling for nearly a decade[24].

Reduced concentration is desirable in ethanol production as a more competitive, less concentrated market structure is generally viewed to be more socially beneficial due to the basic economic theory surrounding competition and market power of a commodity like ethanol[25]. A competitive market requires many sellers, a relatively homogenous product being sold, relatively small market shares held by each firm, a situation where no one seller views its market share as threatened by a competing seller, freely accessible information, and freedom of market entry and exit. With enough firms producing the same product and no one seller holding a sufficient share in the market to be able to influence buyers, then each firm will compete equally and the market price will settle at the point where the marginal cost to producers is equal to the marginal benefit or demand of consumers. Through the process of competition societal benefit is maximized with

[24]FTC, "2006 Report on Ethanol Market Concentration" Federal Trade Commission (2006). 27.
[25] Moreira, Jose R. and Goldember, Jose. "The Alcohol Program," *Energy Policy* (1999) 229-245

an appropriate price to quantity relationship in which, theoretically, the maximum number of consumers is supplied at the lowest price still covering the costs of production[26].

This study assumes that ethanol sufficiently fits the criteria to merit a perfectly competitive market. Both anhydrous and blended ethanol are homogenous. As a traded commodity, ethanol industry information is publicly regulated and open, no significant barriers exist to market entry or exit in the ethanol production industry and currently the deconcentrated nature of the market shows that firms should not perceive a threat to their market share. Thus, the U.S. ethanol production industry seems to be adhering to economic theory and appropriate industrial organization by trending towards a less concentrated market structure[27].

One misperception about the ethanol is that the United States' ethanol production industry is often perceived as a farm based enterprise. However, over half of U.S. ethanol production capacity is currently non-farmer owned. The majority of non-farmer owned production is controlled by large, often multinational companies. The top two ethanol production companies Archer Daniels Midland (ADM) and POET control approximately 34% of all ethanol production and the top five production companies account for roughly 47% of production[28]. By analyzing the breakdown of farmer owned vs. non-farmer owned production capacity currently under construction, it can be seen that U.S. industrial organization is trending quickly towards a more non-farmer owned industrial structure[29]. This is important to the overall market concentration of the United States' ethanol production industry as market deconcentration has traditionally occurred during a time when non-farmer or privately owned capacity decreased as a percentage

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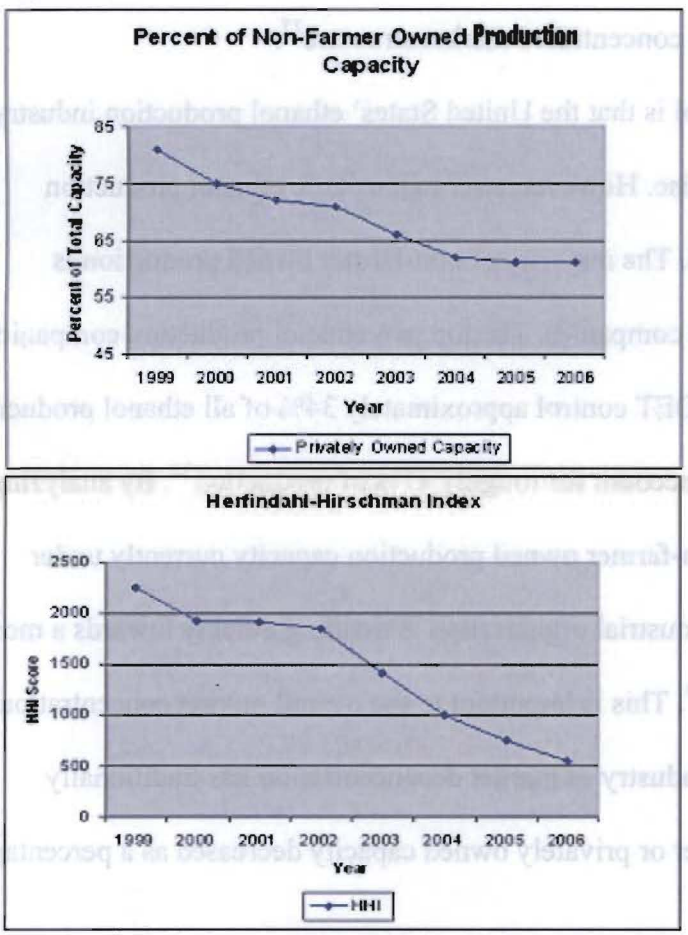
[26] David Hyman. *Economics* (Burr Ridge: Richard D. Irwin inc., 1994), 352
[27] ibid.
[28] Hamza Hasan. "Overveiw of U.S. Ethanol Market." Food First/Institute for Food & Development Policy. http://www.foodfirst.org/node/1723.
[29] Renewable Fuels Association, "Industry Statistics" The Renewable Fuels Association, http://www.ethanolrfa.org/industry/statistics/.

of total production. This indicates that, historically, the distinction between ownership type has been significant in analyzing market concentration [30]. This correlation can be seen in *Figure 3* graphs constructed from FTC data along with data from the RFA. This shift towards a privately dominated industry is evident in the construction of new ethanol plants. Because the production industry looks to double in size within the next three years and a very large majority of the new construction is non-farmer owned the industry will soon be dominated by private firms.

**Figure 3**




[30] Susanne Schill. "Will Consolidation Follow Deconcentration?," *Ethanol Producer Magazine* Febuary. 2007. 4

The trend away from farmer owned cooperative plants is potentially important in analyzing the effects of trade barrier removal on the industrial organization of ethanol. Farmer owned capacity is often viewed as synonymous with cooperative production capacity as most of the farmer owned capacity constructed is organized in a cooperative structure. A farmer owned cooperative is comprised of individuals that have pooled their funds to construct a locally operated production facility. This allows a farmer to gain partial ownership in an ethanol production facility usually with an agreement that at least a specific amount of grain be sold to the facility each year. Farmers share in the dividends of the production facility as well as utilize the sale of ethanol as a means of hedging the risk of crop prices. This distribution of dividends and use of ethanol production as a means of hedging reinvests more of the revenue generated by ethanol production into the rural economy. Yet, it also provides less potential for reinvestment in capital expansion. Cooperatives also have limited access to other sources of capital, most notably venture capital. Since the main goal of a cooperative is to realize market gains and distribute the benefits of these gains amongst its members, it is limited in its ability to reinvest[31]. Because ownership ultimately makes decisions on consolidation and expansion, this study will evaluate the probable effects of trade barrier removal between the U.S. and Brazilian ethanol production industries on both U.S. farmer and non-farmer owned production sectors.

[31] CFA "A Brief on a Canadian Cooperative Investment Plan" *Canadian Federation of Agriculture Publications* (2007) 2.

# III. Review of Literature

Ethanol, as an international commodity and viable substitute for oil consumption, has only recently become a subject of intensive academic research. For this reason, the literature analyzing international ethanol markets is very new and the quantity available is limited. Yet, the studies that are available contain very pertinent and up to date analysis allowing new research in the field of ethanol trade tariffs and subsidization to be relatively cutting edge.

In-depth analysis of trade tariffs and the price effects of trade liberalization is available in a 2007 article for the Journal of Agricultural and Food Industrial Organization's special issue on biofuels. This article analyzes reductions in the tariffs imposed on Brazilian imports of sugarcane ethanol to the United States and vice versa. Using a partial equilibrium trade model, the analysis predicts the effects of industry trade distortions on societal deadweight losses surrounding ethanol trade. Through this process the authors claim that static deadweight loss under current conditions is roughly $80.62 million and that cumulative losses by 2017 would be roughly $2,400 million[32].

In Suani Coelho's report to the United Nations on advantages and trade barriers in the global biofuels markets, the argument is made that trade barriers are making the global development of ethanol problematic. The report shows that Brazil has a clear advantage over the United States in ethanol production with much lower costs. Coelho suggests a move toward trade liberalization. However, Coelho also admits that countries mandating ethanol use and providing

[32] Ariadna Martinex-Gonzalez, Ian M. Sheldon, and Stanley Thompson, "Estimating the Welfare Effects of U.S. Distortions in the Ethanol Market Using a Partial Equilibrium Trade Model" *Journal of Agriculture and Food Industrial Organization* 5 (2007): 227-42.

incentives for domestic production serve to positively promote the learning curve of biofuels production[33].

Paul Gallagher's 2006 study on international competitiveness of the U.S. corn ethanol industry as compared to Brazilian sugarcane ethanol production uses an econometric model to estimate U.S. produced ethanol's ability to compete. In the subsequent time series analysis of competitiveness in trade flows, Gallagher argues that both Brazilian and U.S. tariffs could be reduced for the benefit of both countries. Brazil, he argues, may have less incentive for such action because they are currently using the Caribbean Basin Agreement to re-export ethanol to the United States. However, Gallagher maintains that more so than Brazil, the U.S. may see incentives for the removal of trade barriers. Once barriers are removed Gallagher predicts relatively equal flows between the U.S. and Brazil based on random seasonal factors[34].

David Sandalow's book "Freedom from Oil" provides a new and interesting perspective on the future of trade policy regarding ethanol. Sandalow argues that if the goal of the United States is energy independence its current trade restrictions are "utterly illogical." He maintains that if correctly phased out U.S. tariffs on ethanol importation could benefit the nation without any negative effect to farmers which he notes as a major concern of policy makers. Because current subsidies are given to blenders of ethanol which can process ethanol from any country just as easily, the tariff on ethanol imports is necessary to keep the U.S. from subsidizing international production. In the interest of free trade and societal gain, Sandalow suggests that the trade tariffs on ethanol imports be removed. He argues that in order to counteract this reduction in trade barriers, the 51cent per gallon tax credit/subsidy given to blenders should be

[33] Suani Coelho, "Biofuels – Advantages and Trade Barriers" (Report presented at the United Nations conference on Trade and Development, 1-28, 2005).
[34] Paul Gallgher, "The International Competitiveness of the U.S. Corn-Ethanol Industry: A Comparison with Sugar-Ethanol Processing in Brazil" Agribusiness 22 (2006): 110-134.

given instead directly to ethanol producers. This would keep U.S. ethanol policy from essentially subsidizing foreign production while keeping its ethanol competitively priced[35].

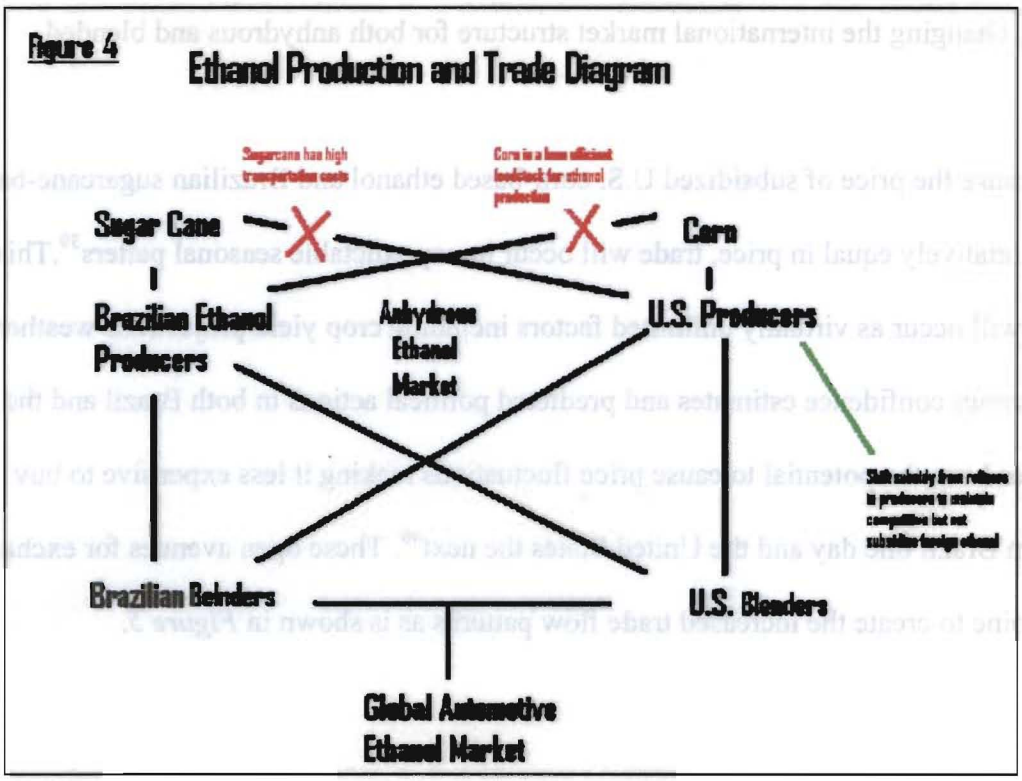
Although there is sufficient argument and economic backing to make a case for removing trade barriers between the United States and Brazil there has been little done to predict the resulting effects on industrial organization due to this removal of trade barriers. This study will expand upon current trade liberalization arguments by attempting to produce significant theory on the effects of trade liberalization on trade flows, economies of scale, and the possibility of market concentration through increased incentives for consolidation. It is expected that the costs to trade liberalization will be outweighed by the potential costs of market consolidation negating the benefits of trade tariff removal.

# IV. Theory and Analysis

According to the most recent literature, removal of trade tariffs would drastically alter trade flows between the United States and Brazil. Following Sandalow's suggestion that the 54 cents per gallon and 2.5% advalorum taxes on imports should be lifted while the U.S. production subsidy for ethanol blenders is shifted to producers and assuming that Brazil would also lift its tariff on imported ethanol, bilateral trade of both anhydrous and blended ethanol would be possible between the U.S. and Brazil as is shown in *Figure 4*. However, unless the 51 cents per gallon subsidy to U.S. blenders is shifted to producers of anhydrous ethanol, the blenders who are able to purchase without regard to the feedstock used to produce anhydrous ethanol could pass the subsidy along to Brazilian producers effectively causing U.S. tax dollars to subsidize

[35] David Sandalow, *Freedom From Oil: How the Next President Can End the United States' Oil Addiction.* (New York: McGraw-Hill, 2008), 189-205.

Brazilian ethanol production. If the subsidy is removed completely U.S. production of anhydrous ethanol would not be able to compete with the cheaper more efficient ethanol production process used in Brazil because of the availability of sugarcane[36].




Because of seasonal variances in the price of feedstock, removal of tariffs on ethanol trade between the United States and Brazil will lead to relatively equal bilateral trade where neither Brazil nor the United States dominates. Instead the two countries will trade with each other rather equally. In these more open markets both anhydrous ethanol producers and blenders would be able to trade their homogenous products to consumer markets in the opposing

[36] David Sandalow, *Freedom From Oil: How the Next President Can End the United States' Oil Addictiion.* (New York: McGraw-Hill, 2008), 189-205.

country[37]. Brazilian blenders would have the opportunity to purchase U.S. corn-based ethanol during times when factor prices make U.S. produced anhydrous ethanol cheaper. U.S. blenders would have exactly the same opportunity to purchase Brazilian anhydrous ethanol. Exchange of this nature means that trade flows would exist after trade barrier removal that were previously unavailable, changing the international market structure for both anhydrous and blended ethanol[38].

Because the price of subsidized U.S. corn-based ethanol and Brazilian sugarcane-based ethanol are relatively equal in price, trade will occur in unpredictable seasonal patters[39].This equal trade will occur as virtually unlimited factors including crop yield projections weather patters consumer confidence estimates and predicted political actions in both Brazil and the United States have the potential to cause price fluctuations making it less expensive to buy ethanol from Brazil one day and the United States the next[40]. These open avenues for exchange would combine to create the increased trade flow patterns as is shown in *Figure 5.*

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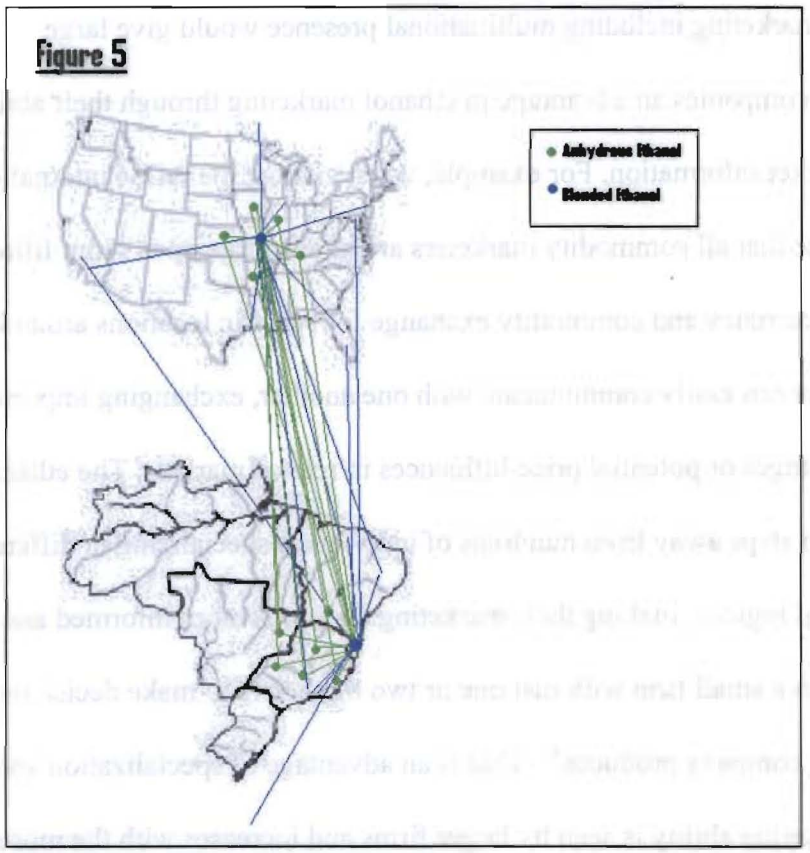
[37] Paul Gallgher, "The International Competitiveness of the U.S. Corn-Ethanol Industry: A Comparison with Sugar-Ethanol Processing in Brazil" Agribusiness 22 (2006): 110-134.
[38] David Sandalow, Freedom From Oil: How the Next President Can End the United States' Oil Addictiion. (New York: McGraw-Hill, 2008), 189-205.
[39] Paul Gallgher, "The International Competitiveness of the U.S. Corn-Ethanol Industry: A Comparison with Sugar-Ethanol Processing in Brazil" Agribusiness 22 (2006): 110-134.
[40] RP Campbell. Personal Interview. Archer Daniels Midland. Decatur, IL., 12 March 2008.




With such an increase in the velocity of trade between the United States and Brazil, it can be assumed that economies of scale will provide larger firms with the ability to lower their costs through more specialized and consolidated departments for management and marketing*, specifically international marketing abilities or the ability to sell effectively in complex international markets will become an advantage to ethanol production firms. Economies of scale occur when the long run average total cost curve declines with increases in output[41]. In a tariff free ethanol market, specialized management and marketing teams would provide for more efficient, lower cost, sales in the now more complex and volatile transnational markets for

* It is important to note that marketing as used in this paper refers to the buying and selling of the commodity ethanol and not the more informal definition referring to a firm's advertising abilities.

[41] Gregory Mankiw, *Essentials of Economics* (Thomson South-Western, 2004), 180-185

ethanol. Specialization in marketing including multinational presence would give large internationally established companies an advantage in ethanol marketing through their ability to more accurately act on market information. For example, when visiting the ADM international headquarters one will notice that all commodity marketers are in one large open room filled with employees specializing in currency and commodity exchange for specific locations around the world. Hundreds of workers can easily communicate with one another, exchanging important information about price changes or potential price influences in related markets. The ethanol marketers for ADM are just steps away from hundreds of individuals specializing in different markets and different global regions, making their marketing decisions more informed and logically more efficient than a small firm with just one or two marketers to make decisions about the sale of the ethanol their company produces[42]. This is an advantage of specialization and more efficient transnational marketing ability is seen by larger firms and increases with the more open international trading. In order to establish efficient scale or the point at which average total cost is minimized smaller firms would see incentives to achieve the marketing advantages held by larger producers.

In order to achieve these newly available economies of scale firms have two basic options. The first option is to expand their production capacities through increasing the size of an existing plant or constructing a new plant. With the use of basic supply and demand analysis it can be seen that increasing a firm's capacity through construction would increase ethanol supply and drive down the price of ethanol making it an undesirable avenue for achieving economies of scale. The second option, consolidation, would achieve scale economies without increasing total ethanol supply. With supply remaining the same, the market price would remain unchanged.

[42] RP Campbell. Personal Interview. Archer Daniels Midland. Decatur, IL., 12 March 2008.

Therefore, acting in their own self interests firms would logically choose to expand through consolidation[43]. One barrier to consolidation is that firms would not want to acquire production facilities which are not technologically up to date as they would then gain in production size but loose in efficiency due to increases in the costs of production for a less advanced plant. However, this is a relative non-issue in the ethanol production industry as the vast majority of production facilities have been constructed in the past five years and can therefore be assumed to be up to date technologically[44].

Once it is established that consolidation will occur, how it will occur must then be implied separately for both farmer owned and privately owned production as this distinction has shown significant influence on market concentration in the past. Despite their unique structure and the dual nature of the benefits received by a farmer owned production facility, economies of scale would still exist for cooperatives and, baring the existence of some values-based objection, cooperatives would act in their own self interest and seek out a new efficient scale[45]. However, as was mentioned earlier the cooperative structure of ownership leaves a farmer owned firm with limited capital for investment. This disadvantage makes most cooperatives unlikely acquisitors in the consolidation process[46]. One option for cooperatives to retain their ownership structure and achieve economies of scale would be to form conglomerated cooperatives and combine the management and marketing from their previously separate production facilities. Without the available capital for the acquisition, the other option for cooperatives would be to sell out to a larger privately owned firm likely to have the capital necessary for the purchase. However, with

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[43] Gregory Mankiw, *Essentials of Economics* (Thomson South-Western, 2004), 180-185
[44] Renewable Fuels Association, "Industry Statistics" The Renewable Fuels Association, http://www.ethanolrfa.org/industry/statistics/.
[45] Renewable Fuels Association, "Industry Statistics" The Renewable Fuels Association, http://www.ethanolrfa.org/industry/statistics/.
[46] CFA "A Brief on a Canadian Cooperative Investment Plan" *Canadian Federation of Agriculture Publications* (2007) 2.

the most recent boom in production farmer owned cooperative capacity continues to decline as a percent of total capacity. As a result its influence on overall market concentration is also declining making the issue of private consolidation more important to overall market concentration.

The path to consolidation for the privately owned firm is more straight-forward. These production companies do not see external benefits due to increases in the price of corn and other grains nor the benefits of rural development due to the fact that they are mostly controlled by absentee owners. Because many private firms have the available capital to invest in the acquisition of capacity through consolidation the option for private firms to achieve economies of scale is to buy up existing production capacity or be bought out. The only other option would be some sort of hybrid private-cooperative where economies of scale were achieved through a more complex mutual agreement between a cooperative and private firm. Therefore, although consolidation would likely occur in various ways depending on plant ownership, it will still likely occur in both the farmer and non farmer owned sectors of the U.S. ethanol industry and lead to a more concentrated industry overall once trade tariffs are removed[47].

Increased consolidation is important to the evaluation of industrial organization as it leads to the possibility of price fixing or monopoly pricing. This process is far from unheard of in the agricultural processing industry as U.S. based ADM and a group of other international firms were convicted of just such an act in 1993. In a more concentrated market the possibility of monopoly pricing or monopoly power becomes available. For the purposes of this research, concepts of monopoly pricing will be used to explain the dangers of market concentration as the

[47] Moreira, Jose R. and Goldember, Jose. "The Alcohol Program," *Energy Policy* (1999) 229-245

similarities in the theory behind monopoly and oligopoly pricing and their relationships to the subject of ethanol production make differentiation unnecessary[48].

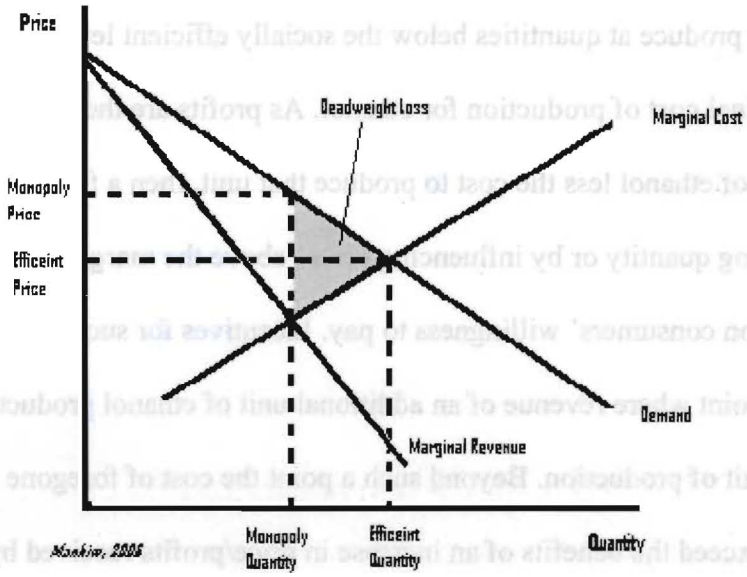
Monopoly pricing in ethanol production would occur when one firm or group of firms gains a large enough share in the market to effectively influence the market price for ethanol. Production firms face incentives to produce at quantities below the socially efficient levels and charge prices higher than the marginal cost of production for ethanol. As profits are the price received by the producer for a unit of ethanol less the cost to produce that unit, then a firm will receive additional profits by reducing quantity or by influencing prices above the marginal cost of production thereby capitalizing on consumers' willingness to pay. Incentives for such behavior can be realized until the point where revenue of an additional unit of ethanol production equals the cost of that additional unit of production. Beyond such a point the cost of foregone ethanol production/supply would exceed the benefits of an increase in price/profits received by the ethanol producers[49].

Although producers of ethanol could improve profits under monopoly price techniques, it results in a net social loss. In a system of monopoly pricing, consumers who would have purchased competitively priced ethanol can no longer afford to do so, resulting in a deadweight loss. Any upward influence on prices or reduction in quantity from the competitive equilibrium will result in a reduction in total surplus or deadweight loss. This loss of societal net benefits is displayed by the shaded gray area in *Figure 6*. The area represents units that remain unsold at points where demand or willingness to pay exceeds marginal cost or supply. Simply stated, in the

[48] Gregory Mankiw, *Essentials of Economics* (Thomson South-Western, 2004), 180-185
[49] Gregory Mankiw, *Essentials of Economics* (Thomson South-Western, 2004), 186

presence of monopoly/oligopoly pricing, fewer consumers realize the benefits of ethanol consumption than would be able to in a competitive market[50].

Figure 6




Since there is the opportunity for trade between the United States and Brazil, making them part of one international market, any oligopoly pricing techniques would have to also include Brazil's dominant producers. Although sufficient data is not currently available for the Brazilian ethanol industry to definitively say weather or not Brazil would increase its market concentration. For the purposes of this study and because there is no available information that would greatly conflict the assumption, it will be assumed that Brazil's production facilities would react to incentives for market consolidation similar to U.S. producers and therefore share the same risks of monopoly/oligopoly pricing. Under this assumption the removal of trade tariffs

[50] ibid

between the U.S. and Brazil should increase overall market concentration and potential for consolidation in both sides of the newly conjoined U.S./Brazilian ethanol market[51].

Since removing trade tariffs to eliminate the deadweight loss associated with them creates the potential for another social deadweight loss through price fixing, logically, trade barrier removal should only occur if it decreases net social loss through the process or if the deadweight loss due to trade barriers is larger than the probable deadweight loss due to monopoly pricing. Because the deadweight loss of monopoly pricing targets consumers based on their willingness to pay it is important to compare the price effects of the existence of trade tariffs to the potential effects of monopoly pricing. Although it is impossible to say for certain what would occur, a likely result can be displayed with production data provided by the RFA and estimated social costs of trade barrier existence.

Assuming that the estimate given in 2007 by The Journal of Agricultural & Food Industrial Organization is accurate, the total cost of tariffs between the U.S. and Brazil up to 2006 has been $80.61 million, the total losses for the United States being $37.96 million. During this time, according to statistics from the Renewable Fuels Association, the United States has produced approximately 38.07 billion gallons of ethanol. To estimate the cost to U.S. consumers of ethanol trade barriers the total net loss due to existence of trade barriers is divided by the total gallons produced during that same time period giving a per gallon cost of barriers to U.S. Brazilian ethanol trade of roughly .10 cents[52]. When referencing this to forgone consumption it must be noted that the lowest available unit for price differentiation is .25 cents in ethanol markets allowing one to compare these two numbers only through the logic that a .10 cents per gallon

[51] Moreira, Jose R. and Goldember, Jose. "The Alcohol Program," *Energy Policy* (1999) 229-245

[52] Ariadna Martinex-Gonzalez, Ian M. Sheldon, and Stanley Thompson, "Estimating the Welfare Effects of U.S. Distortions in the Ethanol Market Using a Partial Equilibrium Trade Model" *Journal of Agriculture and Food Industrial Organization* 5 (2007): 227-42.

loss is a relatively minuscule per gallon cost in relation to how producers and consumers currently value ethanol through commodity prices.

# VI. Conclusions and Policy Implications

Through the theory and analysis provided in this study it can be seen that market concentration in both farmer and non-farmer owned sectors of the production industry and the resulting risk of monopoly pricing will likely rise with removal of tariffs that currently block the bilateral trade of ethanol between the United States and Brazil. In order to merit removal of these tariffs the dead weight loss due to the existence of the trade tariffs must exceed the probable deadweight loss associated with oligopoly power and price fixing. With a per gallon gain of only about .10 cents, from removal of trade tariffs and considering that the consumer is not even allowed to differentiate based on a price changes smaller than .25 cents due to the practices of the commodity trading industry, this study concludes that the benefits of tariff removal could plausibly be negated if any significant costs to market concentration were accrued through monopoly pricing. Simply stated, to the consumer the cost of trade barriers is so small it is essentially unnoticed at the per gallon level amounting to only one tenth of a cent. Although there is no definitive answer based on available data as to weather or not the removal of tariffs on ethanol trade between the U.S. and Brazil would result in a net gain or loss, the potential losses due to market concentration can be significant and even the cost of increased regulation potentially high, given the industry's history. For these reasons this study finds that the potential for monopoly/oligopoly pricing through increased market concentration is a significant factor to consider when discussing the removal of tariffs to trade between the United States and Brazil and should be further researched before action is taken.

Politicians and economists advocating trade barrier removal need to explain more thoroughly the benefits of increased ethanol trade or explain what factors are likely to change making these barriers to trade more costly. This dynamic market is growing and changing at such rates that, there are many factors which are important to the industrial organization and appraisal of industry costs and benefits that could not be incorporated into this study. These factors include but are not limited to such benefits as job creation, increased rural development and costs such as environmental degradation and increases in food costs through a raise in commodity prices. It is also essential to obtain more information about the industrial organization of the Brazilian ethanol production industry and analyze more specifically the potential effects of trade barrier removal on its current structure rather than assume it to consolidate based on the evaluation of the U.S. production system.

This study may have concluded that current practices regarding bilateral trade between the U.S. and Brazil are likely are potentially more efficient than certain proposed changes however, this does not mean that the industry will not continue to evolve. It is also not the purpose of this paper to suggest that trade barrier removal is the only factor to cause market consolidation. It may well be that market consolidation will occur despite a relatively closed trade structure. Based on production capacity currently under construction or expansion, the U.S. ethanol industry will likely double in size within the next three years[53]. Global ethanol projects around the world are also quickly growing to meet demand. Unless demand continues to grow, supply will eventually catch up causing the currently high profits seen by ethanol producers to fall, a change which could also cause industry consolidation to occur. There are many possibilities for the industrial organization of U.S. ethanol and many uncertainties in its future.

[53] Renewable Fuels Association, "Industry Statistics" The Renewable Fuels Association, http://www.ethanolrfa.org/industry/statistics/.

For this reason ethanol and related industries need increased evaluation to better understand the appropriate way to handle developing ethanol markets.

One important comparison for the bilateral trade of ethanol between the U.S. and Brazil is the production of sweeteners. Similar to the current market for ethanol, U.S. artificial sweeteners are produced from corn where Brazilian sweeteners are produced form sugar. These two industries producing relatively homogenous products are kept separate through significant trade barriers. Interestingly enough, even with domestic protection in both markets the U.S. market for artificial sweeteners produced from corn is highly concentrated, composed of 5 major firms controlling 85% of the market[54]. Further study on the similarities and differences in the markets for ethanol and sweeteners would be very beneficial to understanding the proper industrial organization for the still emerging ethanol production industry.

The benefit and the curse of current studies conducted on ethanol is that, as the industry is evolving and emerging, the studies can be up to date and "cutting edge". Yet, by the same reasoning they can also quickly become obsolete as new information surfaces. This study has concluded that, for the time being, the proposed removal of trade tariffs between the United States and Brazil with regard to market concentration and industrial organization would have potentially high costs and relatively insignificant benefits. However, continued study is needed in this area of investigation because, although the markets for automotive fuels like ethanol are constantly changing, the one thing that is not changing is the increasing need for efficient and effective markets for gasoline substitutes.

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[54] Science Direct, "Estimating market power in the presence of capacity corn sweetner" Science Direct College Edition. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V8P-4HC0PND-1&_user=503321&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000024866&_version=1&_urlVersion=0&_userid=503321&md5=b738bec37cd9aab5c3d87474c73fbefa

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