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The Impact of Trade Barriers on Mandated Biofuel Consumption in Canada

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Danny G. Le Roy
Department of Economics
The University of Lethbridge

Amani E. Elobeid
Food and Agricultural Policy Research Institute
Iowa State University

K.K. Klein
Department of Economics
The University of Lethbridge

http://www.catrade.org

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1. Introduction

In 2008 the Canadian government passed amendments to the Environmental Protection Act requiring five percent ethanol in transportation fuels sold in Canada by 2010 and two percent renewable content in diesel and heating fuels by 2012. Agricultural commodity and other groups have lobbied for further marketplace intervention that would ensure the biofuel needed to meet the legislated requirement be produced from domestic sources. Indeed, many of these special interests would like the biofuels content increased from five to ten percent and for the increase to be met by domestic firms only. The objective of this study is to compare the relative economic impacts in Canada of achieving a ten percent biofuel content either through increased imports or by substituting domestic production in place of increased imports.

The paper is organized into five sections. The next section describes the classification of biofuels and existing policies for promoting their production and consumption in Canada. The third section describes the analytical framework used to identify and quantify the effects of realizing a ten percent renewable fuel mandate through either an increase in imports or by an expansion of domestic production. The results are presented in the fourth section. The last section summarizes and concludes the paper.

2. Background

Global biofuel production is increasing rapidly. Total annual output of ethanol has increased to more than 60 billion litres in 2008 from fewer than 20 billion litres in 2001 (Renewable Fuels Association, 2009). Over the same time, the increase in production of biodiesel has been even more dramatic: a 900 percent increase from one billion to nine billion litres (Koplow, 2007). While producers in the United States, Brazil, Canada and the European Union have been responsible for most of the expanded output, those in China, Thailand, Colombia, India and in tropical and sub-tropical regions have increased their production as well.

Ethanol producers in Brazil enjoy a comparative advantage in production. The vast availability of fertile land, favourable weather conditions and inexpensive labour create the economic circumstances that result in the lowest production costs worldwide. On the foundation of inexpensive sugar derived from cane, ethanol producers in Brazil can make ethanol for $0.26 per litre, less than in any other region, according to the World Bank (Kojima and Johnson, 2005). In general, production costs of biofuels (particularly ethanol) are lower in countries that lie in tropical and sub-tropical areas with low land and labour costs. In addition to sugarcane in these areas, other crops such as tapioca, sorghum, and cassava have been used as feed stocks for ethanol production. Palm oil, soybeans, peanuts, coconut, and jatropha have been used to produce bio-diesel.

The comparative advantage of producers in tropical and sub-tropical countries provides an opportunity for specialization and increased trade. However, like many other agricultural commodities, interventionism limits the scope of mutually advantageous exchange across geo-political boundaries. In North America, man-made barriers to trade including per unit and *ad valorem* tariffs reduce the quantity demanded of imported biofuel, and as a result, domestic prices are higher and world biofuel prices lower than they otherwise would be. Delineating and quantifying the trade-offs from biofuel trade barriers, with particular reference to quantities demanded and supplied of biofuels both within and beyond the Canadian market, can supply useful information to help decision makers in the agricultural and energy sectors as well as in government.

As is the case in many other countries, national and regional governments in Canada have implemented policies to encourage biofuel production and usage. In June 2008, the Parliament of Canada passed amendments to the Environmental Protection Act (Bill C-33) that incorporated a mandate for biofuel consumption: an annual average renewable content in Canada of five percent in gasoline by 2010 and two percent for diesel fuel and heating oil by 2012. Earlier, several provinces had implemented their own mandates of renewable fuel consumption: Ontario, five percent ethanol by 2008, Manitoba and Saskatchewan, five to ten percent starting when provincial production is sufficient, and Québec, five percent before the end of 2012. If the opportunity cost of imported biofuel is less than domestically produced biofuel, eliminating import barriers ought to result in a less expensive means to realize these consumption mandates in Canada. The relatively less expensive that biofuel is for final consumers, the more likely they will use it as fuel over available alternatives. In addition to lower prices, imports diversify geographic sources of supply, which enhance the consistency, composition and quality demanded by final consumers. If biofuels are truly to succeed as a motor fuel, they will have to provide superior value to final consumers either from being less expensive than conventional fuels for equivalent benefits, or by providing unique benefits for which consumers are willing to pay a higher price.

To a large extent, biofuel use in Canada has increased as a result of interventionist policy initiatives, the economic consequences of which have been the focus of recent studies (Fridfinnson and Rude, 2009; Mussell and Martin, 2007; Klein and LeRoy, 2007). Policy induced increases in domestic consumption have been met by government assisted expansion of domestic supplies rather than by a rise in imports. The interests of groups in Canada that have promoted this policy approach conflict with the interests of low cost foreign producers who also aim to satisfy the biofuel blending requirements in Canada and elsewhere. While it is unlikely the Government of Canada will allow imported ethanol to realize much of the biofuel consumption mandate, regional differences in the opportunity costs of biofuel production provide the economic basis for increased cross border trade. Moreover, the bigger the potential market for biofuel and the greater the comparative advantage of foreign producers relative to government supported producers in North America and Europe, the higher is the probability of trade disputes because of that government support. To frame the empirical analysis that follows, the next section describes how the World Customs Organization classifies biofuels and the various policies implemented in Canada to promote biofuel production and consumption and to limit imports.

2.1. HS Classification of Biofuels

The World Customs Organization (WCO), founded in 1952, is an intergovernmental organization that helps customs administrations in 173 countries communicate and co-operate on customs issues. The organization has established an international standard classification of commodities called the Harmonized Commodity Description and Coding System (HS). The HS system is used to classify goods for the purpose of applying tariffs and as such it forms a convenient structure for compiling worldwide trade data.

To date, the WCO has no specific HS classification for either ethanol or biodiesel. This not only makes it difficult to get precise biofuel trade flow data, but it also has implications with regard to reducing import taxes on them (Howse et al, 2006; UNCTAD, 2006). The source of these difficulties is the WCO lists biofuels as agricultural or chemical products, not as fuels. Ethanol, listed under HS Chapter 22 (beverages, spirits and vinegar) is considered an agricultural good, while biodiesel falls under Chapter 38 (miscellaneous chemical products) and is thus considered an industrial good.

To make matters slightly more complex, ethanol can be classified as either undenatured ethyl alcohol (HS code 2207.10) or denatured ethyl alcohol (HS code 2207.20). Denaturation involves the deliberate addition of a noxious amount of a substance to a given quantity of ethyl alcohol to make the combination unfit to drink without impairing its usefulness for other purposes. The change in its physical properties renders denatured ethyl alcohol a separate and distinct good from the undenatured variety.

Of the denatured ethyl alcohols, ethanol may be classified as specially denatured (HS code 2207.20.11); denatured (HS code 2207.20.12); denatured, but not in accordance with the specifications prescribed by the Canadian Excise Act and Regulations (HS codes 2207.20.19); and other denatured (HS code 2207.20.90). There is no separate classification or sub-classification for fuel ethanol. With regard to biodiesel, there is an additional classification problem: many other products are listed along with it in HS 3824.90. Separating biodiesel from the long litany of other miscellaneous chemicals is problematic.

Howse et al (2006) identified three issues stemming from the classification problem that need to be clarified in the application of WTO rules: the determination of whether ethanol should be treated as an agricultural, an industrial or an environmental good, the determination of how ethanol subsidies should be treated in terms of existing categories of WTO subsidy rules, and the assessment of compliance of domestic rules with WTO standards on technical barriers to trade.

The distinction between agricultural and industrial goods also has important implications regarding tariffs and the treatment of subsidies under WTO rules. Annex 1 of the WTO Agreement on Agriculture states that the provisions of the Agreement apply to HS Chapters 1 to 24 (except for fish products and a list of products with other HS headings). The Agreement on Agriculture not only has separate rules that affect tariff rates but also different rules with regard to subsidies and other domestic policies that affect trade. Thus, ethanol, an agricultural product, is treated much differently under WTO trade rules than is biodiesel, an industrial product. This implies non-trivial differences in the application of existing WTO obligations related to issues such as whether subsidies directed to the biofuels industry could be viewed as providing downstream subsidization to feedstock suppliers (or vice versa) and whether or not biofuel subsidies serve as cross-subsidies for biofuel co-products.

Further complicating the classification issue is the possible outcome from the Doha Round Negotiations that biofuels might be deemed as environmental goods. If ethanol and biodiesel were classified as environmental goods in the ongoing negotiations on Environmental Goods and Services rather than agricultural or industrial goods, trade barriers likely would be subject to faster reduction.

To date, preferential taxation, subsidies, import tariffs, consumption mandates and other forms of government support have been crucial to the expansion of the biofuels industry not only in Canada, but elsewhere in North America and Europe. The consistency of these policy instruments with international trade rules requires a complex and fact-specific analysis beyond the scope of this paper.

2.2. Promotion in Canada

On 18 July 2006, the Honourable Chuck Strahl, Minister of Agriculture and Agri-Food Canada, announced the federal government intended to mandate that five percent of Canada's transport fuel be renewable by 2010 and two percent renewable content in diesel and heating oil by 2012 on successful demonstration of renewable diesel fuel use under Canadian environmental conditions. Then, on 3 December 2007, the Minister of the Environment, the Honourable John Baird Bill introduced C-33, an Act to amend the Canadian Environmental Protection Act (1999), in the House of Commons. The passage of Bill C-33 on 26 June 2008 enables the federal government to implement and enforce regulations requiring the stated renewable content in transportation and heating fuels.

Based on total use projections in Canada, the renewable fuel requirement could create a demand for 3.1 billion litres of ethanol by 2010 and for 600 million litres of biodiesel by 2012 (Canada Gazette, 2006). Table 1 shows that 16 commercial ethanol plants operating in Canada in April 2009 had the capacity to produce 1.338 billion litres of ethanol annually (Canadian Renewable Fuels Association, 2009). Five additional plants with a combined capacity of 928 million litres annually were under construction (Canadian Renewable Fuels Association, 2009). For biodiesel and heating oil, the April 2009 capacity was 166 million litres (Table 2).

The increase in production necessary to meet the policy objectives for ethanol and biodiesel have led to a flood of proposed projects. In Alberta, for example, the Permelex plant in Red Deer is the only commercial ethanol enterprise in the province as of April 2009. However, there are at least eight proposed projects in the province, of which Dominion Energy Services in Innisfail is the largest, at 374 million litres per year capacity (Riverstone LLC, 2007) and of similar scale as a mid-size plant in the United States. While there are no commercial scale biodiesel enterprises at present in Alberta, at least 13 projects are at various stages of realization (Teel, 2007). If all the proposed biodiesel plants are completed and operate at capacity, the quantity of biodiesel produced in Alberta alone will be more than twice the amount required to meet the national mandate.

The policy induced increase in biofuel production in Canada can be traced back to 17 December 2002 when the federal government ratified the Kyoto Protocol.[1] The prospects for the ethanol industry improved substantially after the government pledged $100 million for the sector as part of the means to realize its Kyoto commitments. Under the initial plan of the federal government, E10 blends (that contain ten percent ethanol and 90 percent gasoline) were to achieve a 35 percent market penetration by 2010. Berg (2004) estimated that this would have resulted in a replacement of 532 million litres of gasoline or 1.33 megatonnes of CO_2, just over one-half of one per cent of the 240 megatonne reduction in greenhouse gas emissions the federal government committed to achieve.

Since 2002, domestic ethanol producers have received and continue to receive subsidies that encourage expansion of the industry. In August 2003, the federal government's Ethanol Expansion Program budgeted $100 million in grants towards capital costs of new or expanding ethanol plants. After two rounds of competitive solicitation in 2004 and 2005, seven loans totaling $78.2 million were approved for a total additional capacity of about 750 million litres per year. According to Fox and Shwedel (2007), repayment terms for these loans were lenient since repayments were contingent on net return targets. A Biomass Ethanol Program also dating from 2003 provided $140 million in lines of credit to ethanol plants in the event the excise tax of $0.10 per litre was re-imposed on fuel ethanol (which it was in 2007).

On 20 December 2006, the federal government announced $345 million in taxpayer transfers to further expand biofuel production. To encourage more farmer participation, $200 million was made available through the Capital Formation Assistance Program (which later was called the EcoAgriculture Biofuels Capital Initiative) (AAFC, 2007a). The remaining $145 million was directed through the Agricultural Bioproducts Innovation Program to promote research and development (AAFC, 2007b).

[1] Policies to promote ethanol in the United States can be traced back to passage of the Energy Tax Act on 9 November 1978. In response to rapidly escalating energy prices, the objective of this law was to mitigate demand for oil and gas by supporting energy conservation, fuel efficiency and the production of renewable sources of energy including ethanol, through taxes and tax credits. During the same period, the policy response to high energy prices in Canada was the National Energy Program (NEP), introduced on 28 October 1980. The NEP was designed to promote oil self-sufficiency, to maintain domestic oil supply for the industrial base in eastern Canada, to promote Canadian ownership of the energy industry, to encourage domestic oil exploration, and to increase government revenues from oil sales through a variety of taxes and agreements.

The 2007 federal budget provided $1.5 billion in subsidies over seven years for producers of ethanol and biodiesel. Government assistance is available up to $0.10 per litre for renewable alternatives to gasoline and up to $0.20 per litre for renewable alternatives to diesel fuel for the first three years, after which the subsidies would decline. In addition, transfers totaling $500 million over seven years will be made to producers of next-generation renewable fuels, such as ethanol from agricultural and wood waste products including wheat straw, corn stover, switchgrass, and wood residue. The $0.10 per litre excise tax exemption was replaced by a $0.10 per litre producer incentive payment.

In 2006, several provinces announced major biofuel incentive programs. The Ontario Ethanol Growth Fund makes available up to $520 million available over the following 12 years to ethanol producers. The Alberta government announced a four-year, $209-million Renewable Energy Producer Credit program that offers tax credits to ethanol and biodiesel producers and distributors. The rate of subsidy is reviewed annually to ensure that it is competitive with other jurisdictions. The Québec government announced a 24-point action plan to help realize some objectives of the Kyoto Protocol. Part of the plan involves a tax on producers of hydrocarbon energy during each of the following six years. The government expects to collect $200 million per year from the carbon tax, which is to be transferred to a Green Fund.

Tables 3 and 4 summarize federal and provincial fuel tax exemptions. The heterogeneous nature of the tax exemptions (amounts, eligibility and duration) creates incentives that divert the pattern of trade from what likely would occur with a uniform tax code. For example, until recently almost all of the ethanol produced in Alberta was exported to the United States because Saskatchewan's tax exemption applies only to provincially produced ethanol. Meanwhile some ethanol produced in Saskatchewan was sold to buyers in Alberta where the provincial tax exemption does not place restrictions on the source of the ethanol.

Table 5 summarizes how federal and provincial support has been extended to all stages of biofuel production from research and development to consumption. Specific instruments that have been used for this purpose include excise tax exemptions, direct producer payments, interest free loans, grants, accelerated depreciation, consumption mandates and tax incentives for consumers buying flex fuel vehicles. According to Lann et al (2009), between 2006 and 2008, total government support in Canada was between $860 million and $1.02 billion, averaging $300 million per year.

2.3. Biofuel Tariffs

Tariffs can be an important source of domestic market price support by limiting competition from foreign suppliers. Table 6 shows that while tariffs on biofuels in Canada are low, those on ethanol (denatured ethyl alcohol) tend to be higher than those for biodiesel (a miscellaneous chemical). The most favoured nation (MFN) tariff, which is extended to all signatories to the General Agreement on Tariffs and Trade, on specially denatured or denatured ethyl alcohol within the meaning of the Excise Act, is

$0.0492 per litre. Importers of other types of denatured ethyl alcohol from MFN countries must pay either $0.1228 per litre or 6.5 percent, depending on the product. The federal government in Canada applies an exception (i.e., no tariff) on biofuel imported from the United States, Mexico, Israel, Costa Rica and Chile as a result of various bilateral trade agreements. Biofuel imported from Brazil notably does not receive an exception.

2.4. Pattern of Foreign Exchange

Figure 1 depicts the quantities imported of various kinds of ethyl alcohol from 1996 to 2006. While biodiesel trade data are difficult to obtain for reasons explained above, data for denatured ethyl alcohol are not. As there is no separate classification for fuel ethanol, imports in Figure 1 represent the maximum amount that could have been used for that purpose. Annual imports of specially denatured ethyl alcohol (HS 2207.20.11), typically used as a solvent and astringent in toners, deodorants, mouthwashes and hairsprays, has varied from a few million litres to over 100 million litres.

Ethyl alcohol denatured within the meaning of the Excise Act (HS 2207.20.12) may be used for a number of industrial purposes. It is composed of a mixture of ethyl alcohol and specified denaturants that may be used in the production of ethanol-fuel mixtures. The best-known ethanol-fuel blend used in Canada is made with grade DA-2F, which contains gasoline as its sole denaturant. The other two grades of fuel-denatured ethyl alcohol, DA-2C and DA-2G, have petroleum derivatives and diesel fuel, respectively, as denaturants. The upshot is that HS 2207.20.12 is a good indicator of fuel ethanol, but other ethyl alcohols could be used for that purpose. Indeed, prior to 1 July 2003, ethanols denatured with gasoline, diesel or other petroleum derivatives were listed with other specially denatured ethyl alcohol (under HS code 2207.20.11). Since 2003, the quantity of imported denatured ethyl alcohol has been variable and falling from more than 100 million litres to less than 50 million litres. Over the same period, imports of other denatured ethyl alcohols have been negligible.

As there is more ethanol produced in Brazil and the United States than all other countries combined (Renewable Fuels Association 2008), it is not surprising that Brazilian and American ethanol producers are the major suppliers to Canadian consumers of foreign-produced ethanol. According to Statistics Canada (2007b), most of the ethanol imported into Québec comes by ship from Brazil; in Ontario, most of the imported ethanol comes by truck from the United States. Ethanol also is imported from the United States into Saskatchewan, Alberta, Manitoba, British Columbia and Québec (Statistics Canada, 2007b). Less important foreign suppliers include those from Austria, Ireland, Italy, Japan, and the United Kingdom (Statistics Canada, 2007b).

Exports of denatured ethanol from Canada have been small compared to domestic consumption, and especially with regard to the quantity of ethanol exported from Brazil. Figure 2 reveals that annual exports from Canada between 1997 and 2005 ranged between 8 and 18 million litres. Exports jumped dramatically in 2006 to 36 million litres, mostly because of increased demand in the United States. According to Statistics

Canada (2007b), denatured ethyl alcohol was exported from only three provinces: Ontario (where most of the commercial distilling capacity is located), Alberta and Saskatchewan. While the United States is a destination for denatured ethyl alcohol exports from all three provinces, exports from Alberta also were destined for South Africa, Iran and France. Ontario was a supplier to consumers in Georgia, the Russian Federation, Ukraine, Japan, Haiti, Greece, Turkey, Israel, India, Germany and the United States (Statistics Canada, 2007b).

Federal and provincial governments in Canada, like governments in other OECD countries (Steenblik 2007), have promoted biofuels using various policy instruments. With effective import barriers, biofuel prices will be higher in Canada than they otherwise would be and world biofuel prices will be lower. This has important implications for the quantities demanded and supplied of biofuels both within and beyond the Canadian market. While federal policies in Canada have been designed to impose a minimum five percent of Canada's transport gasoline by 2010, some interest groups have called on federal and provincial governments to increase the mandated content beyond that level (Ontario Corn Producers Association, 2008).

In the following section, an analytical framework is developed to assess the impact of two alternative scenarios: [1] the impact of an increase in Canadian ethanol demand to ten percent of domestic liquid fuel consumption by 2011, met through increased ethanol imports, and [2] the impact of the same increase met only through increased domestic supply. In the second scenario, ethanol imports are held at the baseline levels and all additional ethanol demand is satisfied from domestic ethanol sources at a higher "made-in-Canada" price. To maintain the higher price for ethanol some form of trade barrier, tax exemption, subsidy program or domestic use requirement would be necessary. While any or all of these trade barriers would be open to challenge under the North American Free Trade Agreement or at the WTO, identifying and quantifying their economic impacts is important given the political pressure to insure demand is met locally.

3. Model, Data, and Procedures

3.1. FAPRI Modeling System

A customized version of the deterministic Food and Agricultural Policy Research Institute (FAPRI) modeling system (Figure 3) was used for the analysis. The FAPRI modeling system is a multimarket, partial equilibrium model of dairy, grains, livestock, oilseeds and sugar that are produced, consumed and traded across key geo-political regions. This modeling system provides a means to assess the consequences of policy changes as deviations from a ten-year projection of commodity supply and utilization. Since the models for each sector can be linked, it is possible to analyze how changes in one commodity sector affect other sectors and countries in the system over a specified future time horizon. Finally, and more importantly, the modeling system incorporates an international ethanol model that includes important regional sources of demand and supply, including the United States and Brazil.

Each commodity group modeled in the FAPRI modeling system includes the largest sources of demand and supply in that market.[2] World market clearing commodity prices in the model are obtained by equating world supply to world demand. For certain countries and commodities, domestic prices are solved endogenously as the outworking of the interaction of domestic demand with both foreign and domestic sources of supply. This means that within each country, the equilibrium price equates supply and demand in the domestic market. For the remainder, because the data is lacking, price transmission equations are used to estimate domestic prices as a function of world prices. Since the resulting domestic prices in the model do not equate domestic supply and demand, net trade is calculated as a residual (i.e., production – consumption + change in stocks). Various national agricultural and trade policies, which affect incentives of buyers and sellers, are included. The maintained assumptions of the modeling system include: [1] that current agricultural policies remain in force in all modeled nations; [2] that average weather conditions continue; and, [3] that technological change continues at historical rates. In each country, all prices are denominated in real terms in local currency.

For this study, the international ethanol model was linked to a United States crops model and to an international sugar model through prices and trade. Both the United States crops and the international sugar models are partial-equilibrium models. The United States crops model includes behavioral equations for crop areas, domestic feed, food and industrial uses, trade, and ending stocks. The model solves for the set of prices that equate annual supply and demand in all markets. The international sugar model is a world model, where a representative world sugar price is solved by equating excess supply and excess demand across modeled countries. The three models (United States crops, ethanol and sugar) are solved simultaneously to solve for equilibrium prices in United States crops, ethanol and ethanol co-products, and for world sugar.

A baseline is established prior to evaluating policy scenarios. This means that the models are solved to provide ten-year projections on production, consumption, trade and prices based on macroeconomic assumptions (GDP, exchange rates, population, etc.) and current agricultural, trade and ethanol related policies. Once the baseline is established, a specific scenario is run and the results are compared to the baseline. These scenarios include changes in trade and domestic policies or changes in certain variables such as crop yields and energy prices.

3.2. Canadian Ethanol Submodel

The Canadian ethanol submodel was developed and embedded within the international ethanol model. The country submodels are composed of behavioral equations for production, consumption, ending stocks, and net trade. In addition to Canada, complete

[2] More details on the FAPRI modeling system are provided at http://www.fapri.iastate.edu/models/.

country ethanol submodels are specified for the United States, Brazil, China, India, and EU-25. Because of limited data, only net trade equations are included for Japan, South Korea, and a rest of the world (ROW) region.

The ethanol model solves for a world ethanol price by equating excess supply and excess demand for the product across countries. The model links domestic ethanol prices in most countries to the world price using price transmission equations, policy wedges and exchange rates. However, in the Canadian submodel, the domestic price of ethanol is solved by equating domestic supply to domestic demand (see Section 3.2.3. for more details). Specifically, the model solves for a baseline which provides the ten-year projections for Canadian ethanol production, consumption and trade given macroeconomic assumptions and current domestic and trade policies. The model solves for an equilibrium ethanol price which clears the market.

Since ethanol price data were not readily available, a historical ethanol price series was constructed using the Canadian average retail gasoline price to estimate a wholesale gasoline price. The ethanol price was calculated as the wholesale gasoline price at a discounted rate. For the purpose of simplification, the Canadian ethanol submodel does not include provincial level policies and it assumes that ethanol is produced mainly through dry milling processes where the only co-product is distillers' grains.

3.2.1. Canadian Ethanol Demand

In the conceptual framework, the demand for fuel ethanol does not arise from the desire of final consumers to acquire and use it to satisfy their individual wants. Rather, it is driven by the imposition of blending requirements which means, from the perspective of a manufacturer of vehicular fuels, ethanol must be a complementary factor of production. The portion of ethanol used can vary, but it must be at least the legislated minimum.

Within this policy context, ethanol demand in Canada is modeled as a conditional factor demand obtained from the cost function for refiners blending gasoline with additives, including ethanol. The cost function is $C = C(P_E^{CA}, P_G^{CA}, Policy, Q_{GS}^{CA})$, where Q_{GS}^{CA} is the refiners' output, which is the gasoline supply, P_E^{CA} is the Canadian price of ethanol, P_G^{CA} is the Canadian price of gasoline (a function of the crude oil price), $Policy$ is federal legislation that affects ethanol demand, and CA denotes the country of Canada. Under the constant-returns-to-scale assumption, the cost function can be written as $C = \tilde{C}(P_E^{CA}, P_G^{CA}, Policy) \cdot Q_{GS}^{CA}$. The marginal cost ($MC_G$) of gasoline is constant as long as input prices are constant. Gasoline output Q_{GS}^{CA} eventually is determined by the intersection of gasoline demand and MC_G at the equilibrium in the gasoline market. By application of Shepherd's lemma, the conditional factor demand for fuel ethanol, ($\partial C / \partial P_E^{CA}$), is

(1) $E_F^{CA} = \frac{\partial C}{\partial P_E^{CA}} = Q_{GS}^{CA} \cdot \left(\frac{\partial \tilde{C}}{\partial P_E^{CA}} \right)$,

where E_F^{CA} is Canada's fuel ethanol demand and $\partial \tilde{C} / \partial P_E^{CA}$ is the proportion demanded of ethanol per unit of gasoline. The quantity demanded of ethanol per unit of gasoline is specified in the following equation:

(2) $\frac{\partial \tilde{C}}{\partial P_E^{CA}} = \alpha_1 + \beta_1 \cdot P_E^{CA} + \phi_1 \cdot P_G^{CA} + \delta_1 \cdot Policy$,

where $Policy$ is the requirement of ethanol blend in percentage. The proportion of ethanol per unit of gasoline, $\partial \tilde{C} / \partial P_E^{CA}$ is a function of the Canadian price of ethanol, P_E^{CA}, the Canadian price of gasoline, P_G^{CA}, and the proportion of ethanol in vehicular fuels, $Policy$. In equation (2), $\alpha_1, \phi_1, \delta_1 > 0$ and $\beta_1 < 0$.

The term Q_{GD}^{CA} denotes the Marshallian demand for gasoline in the Canadian market and is specified as:.

(3) $Q_{GD}^{CA} = \alpha_2 + \beta_2 \cdot P_G^{CA} + \delta_2 \cdot P_E^{CA} + \phi_2 \cdot GDP^{CA} + \varphi_2 \cdot Pop^{CA}$,

where P_G^{CA} is the price of unleaded gasoline in Canada, GDP is real gross domestic product in Canada is GDP^{CA}, and Pop^{CA} is population. Consumers respond positively to a decrease in the price of the composite fuel, which is a function of the prices of gasoline and ethanol. The ethanol component of the composite aggregate fuel consumption increases as the ethanol price falls relative to the price of gasoline to capture the substitution between the types of gasoline at the gas-station pump. In equation (3), $\beta_2, \delta_2 < 0$ and $\alpha_2, \phi_2, \varphi_2 > 0$.

In equilibrium in the gasoline market, the quantity of gasoline supplied by refiners, Q_{GS}^{CA} , is equal to the quantity of gasoline demanded by final consumers (Q_{GD}^{CA}), i.e., $Q_{GS}^{CA} = Q_{GD}^{CA} = Q_G^{CA}$. Substituting equations (2) and (3) into equation (1) yields the conditional factor demand for ethanol evaluated at the equilibrium of the gasoline market, E_{F*}^{CA}:

(4) $E_{F*}^{CA} = \frac{\partial C}{\partial P_E^{CA}} = \left[\alpha_1 + \beta_1 \cdot P_E^{CA} + \phi_1 \cdot P_G^{CA} + \delta_1 \cdot Policy \right] \cdot Q_{GD}^{CA}$

At the equilibrium of the gasoline market, $\partial \tilde{C} / \partial P_E^{CA}$ can be interpreted as the share of fuel ethanol in total gasoline consumption ($E_{F*}^{CA} / Q_{GD}^{CA}$).

3.2.2. Canadian Ethanol Supply

Ethanol supply in Canada is based on a profit equation expressed as return per bushel of feed stock (corn and wheat) net of energy cost. The net return for ethanol plants is calculated as the sum of the price of ethanol including the incentive to producers plus the price of the co-products in ethanol production (distillers' grains) minus the cost of the feed stocks (corn and wheat) and the other costs of producing the ethanol. This net return is expressed in per bushel of feedstock in equation (5). To account for the different feed stocks in ethanol production, the relative marginal costs for each feedstock are weighted by the share of feedstock in total production of ethanol in Canada; s_{CN} is the share of corn-based production in total ethanol production, and s_{WH} is the share of wheat-based production. Thus, the net return per bushel of feedstock for ethanol plants in the Canada π^{NET} is expressed as:

(5) $$\pi^{NET} = \gamma_E \cdot (P_E^{CA} + I) + (\gamma_{DG} \cdot P_{DG}^{CA}) - (s_{CN} P_{CN}^{CA}) - (s_{WH} P_{WH}^{CA}) - m \cdot CP^{CA}$$

In equation (5), I is the monetary incentive offered to Canadian ethanol producers, P_{DG}^{CA} is the price of distillers' grains (a co-product in ethanol production from wheat and corn), P_{CN}^{CA} is the price of corn and P_{WH}^{CA} is the price of wheat. S_{CN} and S_{WH} is the share of corn-based ethanol and wheat-based ethanol in total ethanol production in Canada, respectively. CP^{CA} is the cost of production in Canadian dollars per gallon, which is multiplied by m to convert it to Canadian dollars per bushel. The conversion rates (γ_i) are used to convert each price to dollars per bushel. The conversion rate for ethanol is 2.64 gallons per bushel of feedstock and increases over the projection period to reach 2.8 gallons per bushel to reflect changes in technology. All prices are expressed in real terms. Ethanol production (Y^{CA}) is given as:

(6) $$Y^{CA} = \alpha_3 + \beta_3 \cdot \pi^{NET} + \delta_3 \cdot Y_{t-1},$$

where Y_{t-1} denotes the lagged production in million gallons. In equation (6), $\alpha_3, \beta_3, \delta_3 > 0$. Estimated parameters for the model are shown in Table 7.

3.3. Empirical Procedures

For each scenario under investigation (i.e., achieving a ten percent biofuel content either through increased imports, or by substituting domestic production in place of increased imports) there is an excess demand for ethanol in Canada. In the empirical model, equation (4) defines domestic ethanol demand and domestic ethanol supply is characterized by equation (6). In the baseline and in the first scenario, where the increased demand from the higher (ten percent) mandate is met by increased imports of ethanol, net imports are calculated as a residual (consumption minus production) and the domestic price of ethanol is determined through a price transmission equation, which equates the domestic price to the world price plus the import tariff plus transportation costs.[3]

However, in the second scenario, where net imports are fixed at baseline levels so that the increased demand from the ten percent mandate is met by domestic production, prices are solved endogenously in the model. In other words, domestic prices are

[3] The model is designed to handle the case where the domestic price is lower than the landed price but this situation was never encountered.

obtained in the model by equating the sum of baseline net imports plus domestic ethanol supply to domestic ethanol demand.

All the models were calibrated on the most recently available data (2006). Data for commodity supply and utilization were obtained from the F.O. Lichts Online Database, the Food and Agricultural Organization (FAO) of the United Nations (FAOSTAT Online), the Production, Supply and Distribution View (PS&D) of the United States Department of Agriculture (USDA), and the European Commission Directorate General for Energy and Transport. Macroeconomic data were gathered from various sources, including the International Monetary Fund and Global Insight. Global Insight also provided projections for macroeconomic variables such as exchange rates, GDP and GDP deflators, which are used in the model to provide supply and utilization projections.

Canadian production, consumption and trade data were obtained from USDA's Foreign Agricultural Service Attaché Reports. The data includes both fuel and non-fuel ethanol. The crude oil price is the price of Lloyd Blend 22 crude oil obtained from Energy Information Agency and the Canadian gasoline consumption is the domestic sales of motor gasoline from Statistics Canada. The corn price is the cash price (in store, Chatham) for No. 2 CE corn[4]. For wheat, the farm price is a weighted average of soft and durum wheat based on area shares. Both corn and wheat prices are from Agriculture and Agri-Food Canada.

Two types of analyses were conducted: static and temporal. The static analysis involved a comparison of estimated impacts for the year 2011, one year after the current mandated five percent ethanol content would come into force, with a ten percent ethanol consumption mandate. Projected gasoline consumption in Canada in 2011 was based on Canadian gasoline consumption of 40.6 billion litres in 2006 (FAS, 2007), modified by arguments in the demand function for gasoline in Canada (Equation 3). Supply of ethanol to fulfill the ten percent mandate was modeled with and without additional trade barriers. In the ten percent case with additional trade barriers, it was assumed that the level of ethanol imported into Canada would not rise above the level in the base case and all remaining supply would have to be provided by Canadian firms. In this scenario, the ten percent mandated consumption of ethanol by 2011 is imposed and the imports are fixed at the baseline levels with domestic producers fulfilling the increased demand for ethanol. Since ethanol imports are fixed, the model solves for a domestic ethanol price which equates domestic supply and demand. In the ten percent case with no additional trade barriers, it was assumed that as much ethanol as necessary could be imported to fulfill the ten percent mandate. In this case, the ten percent mandate is imposed and the model is allowed to run to determine the level of imports necessary to meet the additional demand. Imports are determined as a residual (consumption minus production) and the domestic ethanol price in Canada is determined by the price transmission equation (domestic price = world price + import tariff + transportation).

[4] CE is an acronym for "Canada Eastern" and is used by the Canadian Grain Commission to differentiate corn grown in Western Canada from that produced in the East.

The FAPRI Model was used to generate a ten-year stream of production, consumption, trade and price estimates for all variables. This facilitated the temporal analysis. Based on the 2006 starting conditions, the model was used to estimate production, consumption, price and other variables on an annual basis until 2016. The baseline level of ethanol consumption was projected to rise from one percent in 2006 to five percent in 2010 (in line with the currently legislated mandate), then grow slowly to reach eight percent in 2016 (Figure 4)[5]. This baseline consumption path was determined by the model, i.e., the mandate was not imposed exogenously in the model. Rather, given the macroeconomic and policy assumptions, the model solved for consumption levels that reached the mandate of 5 percent in 2010 and increased gradually thereafter. This is in contrast to the scenarios, where the ten percent mandated level of consumption was imposed in the model meaning that the model did not solve for these levels. In this case, the ethanol content was increased exogenously from two percent in 2007 to reach ten percent in 2010, then held at that level until 2016 (Figure 4). As in the static analysis, fulfilling the ten percent mandate could be done with and without additional trade barriers. The impacts of each scenario are measured as deviations from the baseline for the years 2007 to 2016. The averages of these annual changes are reported as summary indicators of the impacts.

4. Results

The static estimates of Canadian ethanol production, consumption, imports and price for 2011 under the three cases are shown in Table 8. The baseline projection for 2011 (where five percent of the gasoline supply is made up of ethanol), ethanol consumption in Canada was estimated to be 2.198 billion litres. That would be supplied by 1.343 billion litres of domestic production and 855 million litres of imports. The estimated production is almost equivalent to the 1.338 billion litres of production capacity available in Canada in April 2009 (Table 2). Of course, the model's estimates are based on data that was available in 2006. At the time of writing, taxes imposed on importers of biofuels remain in place and several ethanol plants are under construction in Canada (Table 2) – more than enough to satisfy the five percent mandate.

A ten percent mandate for ethanol content would lead to an estimated consumption of 3.996 billion litres of ethanol in 2011 if trade barriers prevented additional ethanol imports (Table 8). This would come from domestic production of 3.141 billion litres of ethanol and the same amount of imports: 855 million litres. If additional trade barriers were not imposed, Canadian consumption of ethanol would rise to 4.211 billion litres. With no increase in production from the base case (five percent mandate), all of the increase in consumption (2.868 billion litres) would be supplied by imports (Table 8). In

[5] Several baselines were developed and assessed before deciding on a slowly rising baseline (as shown in Figure 4). One possible baseline would have taken ethanol consumption to five percent in 2010 and then maintained it at that level. However, with continuing interest and growth in the biofuel sector, especially considering the objectives and incentives in the United States Energy Independence and Security Act, it was decided that a baseline that grew slowly but steadily would provide a more realistic basis for comparison.

the ten percent case with trade barriers, the price of ethanol is estimated to rise to C$ 1.13 per litre (Table 8), resulting in lower overall gasoline consumption than would be the case with no additional trade barriers.

Results from the temporal analysis, where Canadian ethanol content in gasoline rises to ten percent by 2010, are shown in Table 9. In the case where effective trade barriers prevent the importation of additional supplies of ethanol, the increased consumption must be satisfied entirely by domestic production. Compared with the base, ethanol consumption would increase by an average of 1.016 billion litres per year over the ten year period (from 2.306 billion litres to 3.322 billion litres) – a 44 percent increase. Domestic production would increase, on average, by 69 percent. Canadian ethanol price would increase an average of 48 percent over the period but would range as much as 90 percent higher in 2011 when the difference between the ten percent mandate and the baseline is the greatest. Since ethanol imports would remain unchanged in this case, there would be no response in the world ethanol price and Brazilian exports.

In the case where no additional trade barriers are imposed, annual ethanol consumption (over the ten year period) is estimated to increase by 1.119 billion litres per year (48 percent over the baseline). The higher consumption of ethanol in this case is a result of the imports, which keeps the Canadian ethanol price nearly unchanged from the baseline. Because of the higher mandated consumption, domestic ethanol prices are expected to increase slightly (by about $C 0.01/litre) and world ethanol prices would increase by six percent (not shown in the table). In response to the six percent increase in world ethanol prices, domestic production of ethanol would increase marginally by an average of seven million litres per year (over the baseline). To meet the expected average quantity of ethanol demanded in Canada of 3.425 billion litres, average annual imports of ethanol would increase 132 percent from 0.840 billion to 1.952 billion litres. The model projects that ethanol producers in Brazil would be the most important source of increased foreign supplies in Canada (not shown in tables of results). Figure 5 shows the temporal impacts of the increased import demand on the world ethanol price as estimated by the model. The increased demand for ethanol over 2007-2016 in Canada would lead to a US$0.09 – US$0.18 per U.S. gallon increase in world prices in the short term relative to the baseline scenario. The difference falls to about US$ 0.05 per U.S. gallon by the end of 2016.

5. Summary and Implications

This study analyzed the effects of an increase in the demand for biofuels in Canada met either solely through domestic production or through trade. The empirical analysis focused on ethanol because of the difficulty of sourcing and segregating trade flow data for other biofuels, most notably biodiesel.

The results of the analysis show conclusively that import barriers favour domestic suppliers of ethanol at the expense of consumers. Import barriers injure Canadian consumers by limiting their access to supplies offered for sale at lower prices by more efficient producers, particularly those that are located in subtropical regions that face lower costs of land and labour. With freer trade, the domestic ethanol price would fall while the world price would rise as a consequence of the higher demand for ethanol in Canada. Given their comparative advantage in producing ethanol, Brazilian suppliers would respond to the higher world price by increasing production and exportation of ethanol.

This study shows that, while trade barriers isolate the Canadian ethanol market from the world market, freer trade would expand the ethanol market. Tariffs and other import restrictions directly undermine the effectiveness and increase the costliness of a higher consumption mandate. The relatively less expensive that ethanol is for the final consumer, the more likely those consumers will use it as fuel over available alternatives. The implication is that restricting imports of ethanol is counterproductive to the policy objective of increasing domestic ethanol consumption. The results of the study also reveal that eliminating import barriers would be costly for ethanol producers in Canada. In response to the lower prices they would receive, the quantities of ethanol they would offer for sale would decrease.

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Table 1: Ethanol Plants in Canada, April 2009

Company	City	Province	Year Commencing	Feedstock	Capacity (millions litres per year)
In Production					
Husky Energy Inc.	Minnedosa	MB	1981	wheat	10
Greenfield Ethanol	Tiverton	ON	1989	corn	3.5
Poundmaker	Lanigan	SK	1991	wheat	12
Greenfield Ethanol	Chatham	ON	1997	corn	120
Permolex	Red Deer	AB	1998	wheat	40
Iogen	Ottawa	ON	2004	wheat straw	3
Suncor Energy	St. Clair	ON	2006	corn	200
Husky Energy	Lloydminster	SK	2006	wheat, corn	130
NorAmera Bioenergy	Weyburn	SK	2006	wheat, corn	25
Husky Energy (expansion)	Minnedosa	MB	2007	wheat, corn	120
Collingwood Ethanol	Collingwood	ON	2007	corn	50
Greenfield Ethanol	Varennes	QC	2007	corn	120
Terra Grain Fuels	Belle Plaine	SK	2008	wheat	150
Greenfield Ethanol	Johnstown	ON	2008	corn	200
Integrated Grain Processors Co-operative	Aylmer	ON	2008	corn	150
Enerkem	Westbury	QC	2009	wood waste	5
Total Production Capacity					**1338**
Under Construction					
North West Bio-Energy & Terminal	Unity	SK	2009	wheat	25
Kawartha Ethanol	Havelock	ON	2009	corn	80
Greenfield Ethanol	Edmonton	AB	2012	municipal waste	36
Northern Ethanol	Niagara Falls	ON	2011	corn	409
Northern Ethanol	Sarnia	ON	2011	corn	378
Expected Total Production Capacity by 2012					**2266**
On Hold					
Greenfield Ethanol	Hensall	ON	2010	corn	145
Suncor Energy	St.Clair	ON	2011	corn	200
Status Unknown					
Okanagan Biofuels	Kelowna	BC	2007	wheat	114

Sources: Canadian Renewable Fuels Association (2009); Laan et al. (2009).

Table 2: Biodiesel Plants in Canada, April 2009

Company	City	Province	Year Commencing	Feedstock	Capacity (millions litres per year)
In Production					
Biox Corporation	Oakville	ON	2001	mixed	1
Milligan BioTech	Saskatoon	SK	2002	canola	1
Rothsay	Montréal	QC	2005	animal fats / yellow grease	30
Ocean Nutrition Canada	Mulgrave	NS	2006	fish oil	9
Biox Corporation	Hamilton	ON	2007	mixed	66
Western Biodiesel	Aldersyde	AB	2008	recycled fryer oil / animal fats/ canola oil	19
Milligan BioTech	Foam Lake	SK	2008	canola	10
Biodiesel Québec	St-Alexis-des-Monts	QC	2008	recycled fryer oil	10
Greenway Biodiesel	Winnipeg	MB	2009	canola oil	20
Total Production Capacity					**166**
Under Construction					
Kyoto Fuels	Lethbridge	AB	2009	mixed	66
Birfrost Biodiesel	Arborg	MB	2009	canola	3
Eastman Bio-Fuels	Beausejour	MB	2009	canola oil and recycled fats	11
Methes Energies	Mississauga	ON	2009	mixed	25
Canadian Bioenergy	Edmonton	AB	2010	vegetable oils	225
BioStreet Energy	Vegreville	AB	2010	canola	175
Expected Total Production Capacity by 2012					**670**
On Hold					
BioNex Energy	Olds	AB		canola	20
Canadian Bioenergy	Fort Saskatchewan	AB		canola	227
Cansource Biofuels	Mayerthorpe	AB		canola	10
Status Unknown					
Green Machine Biofuels	Kelowna	BC		mixed	1
General Bio Energy	Regina	SK		veg.oils	200

Sources: Canadian Renewable Fuels Association (2009); Laan et al. (2009).

Table 3: Federal Tax Exemptions for Fuel Ethanol in Canada

Initiative / Program	Start Date	End Date	Description	Funding
Tax Exemptions for Renewable Fuels (Excise Tax Act)	1992 (ethanol) 2003 (biodiesel)	March 31 2008	Encourages the use and production of renewable fuels in Canada by implementing an exemption from the federal excise tax of $0.10/litre on ethanol and $0.04/litre on biodiesel.	
Removal of Excise Tax Exemption for Renewable Fuels	April 1, 2008		Eliminates the excise tax exemptions for ethanol and biodiesel. This measure is in accordance with the implementation of the ecoENERGY for Biofuels Initiative.	
ecoENERGY for Biofuels	Announced July 5, 2007 / Effective April 1, 2008	March 31, 2017	Aims to boost Canada's production of renewable fuels such as ethanol and biodiesel by providing operating incentives to producers of renewable alternatives to gasoline and diesel based on production levels and other factors. This initiative will make investment in production facilities more attractive by partially offsetting the risk associated with fluctuating feedstock and fuel prices. Incentive rates will be up to $0.10/L for renewable alternatives to gasoline and up to $0.20/L for renewable alternatives to diesel for the first 3 years, then decline thereafter. Incentives are available to eligible facilities meeting a minimum production volume (undetermined) constructed before March 31, 2011, subject to program volume limits (2 B litres of renewable alternatives to gasoline and 500 M litres of renewable alternatives to diesel with a cap of 30% of program volume limits per facility) for up to 7 years.	Up to $1.5 B over 9 years

Source: anonymous reviewer.

Table 4: Provincial Tax Exemptions for Fuel Ethanol in Canada

Initiative / Program	Start Date	End Date	Description	Funding
BRITISH COLUMBIA				
Renewable Fuels Incentive			Road Tax Exemption: $0.1375/L in the Greater Vancouver Service Region and $0.0775 outside of this region for ethanol; $0.1425/L in the Greater Vancouver Service Region and $0.0825/L outside of this region for biodiesel (provided the ethanol and biodiesel are consumed in British Columbia).	
ALBERTA				
Bioenergy Producer Credit Program	Announced October 2006 / Effective April 1, 2007	March 31, 2011	Encourages the production and incorporation of bioenergy products (ethanol, biodiesel, biogas-electrical) within the marketplace; helps Alberta industry effectively compete with other jurisdictions that provide programs and tax exemptions to distributors who blend biofuels; and enables the introduction of renewable products into the traditional fuels and energy marketplace. This approved initiative is part of Alberta's Nine-Point Bioenergy Plan and will replace the existing Alberta ethanol fuel tax exemption policy of $0.09/litre. Credits are given to producers of biofuels or biogas of $0.14/litre (production capacity less than 150 M litres/year, up to a maximum of $15 M/year) or $0.09/litre (production capacity of or greater than 150 M litres/year, up to a maximum of $20 M/year and total of $75 M for the project). Those generating electricity receive $0.02/kWh (production capacity of or greater than 3 MW) or $0.06/kWh (production capacity less than 3 MW).	$209 M for renewable fuels $30 M for commercialization support (from the Energy Innovation Fund)
SASKATCHEWAN				
Renewable Fuels Incentive			Fuel Distributor Tax Credit for Ethanol: up to $0.15/L, 5 years, provided the ethanol is produced and consumed in Saskatchewan.	
MANITOBA				
Renewable Fuels Incentive		August 2007	Provincial Fuel Tax Credit for ethanol: $0.20/litre, provided the ethanol is produced and consumed in Manitoba.	
	September 2007	August 2010	$0.15/litre, provided the ethanol is produced and consumed in Manitoba.	
	September 2010	August 2013	$0.10/litre, provided the ethanol is produced and consumed in Manitoba.	
Renewable Fuels Incentive			Provincial Fuel Tax Credit for biodiesel: $0.115/L, provided the biodiesel is consumed in Manitoba.	

ONTARIO				
Ontario Ethanol Growth Fund (OEGF)	Announced June 17, 2005		Provides 1) capital assistance (not exceeding $0.10/L of plant capacity) in the form of capital grants or loan guarantees for eligible new or expanding ethanol plants being built in Ontario to help meet financial challenges; 2) operating grants (not exceeding $0.11/L of ethanol produced in a particular year for a maximum of 750 M litres per year paid over a period of up to 10 years) to eligible producers in production from 2007-2016 to address changing market prices; 3) support for independent blenders of ethanol and gasoline; and 4) a R&D fund to pursue opportunities for research and innovation.	$520 M over 12 years (up to $32.5 M available for capital assistance for all proponents combined)
Renewable Fuels Incentives		December 2006	Excise tax exemption of $0.145/L for ethanol	
Renewable Fuels Incentive	June 2002		Excise tax exemption of $0.143/L for biodiesel, provided the biodiesel is consumed in Ontario.	-
QUEBEC				
Renewable Fuels Incentive (2005-06 Budget)	April 1, 2006	March 31, 2018	Variable Rate Income Tax Credit for Ethanol: up to $0.185/L, provided the ethanol is produced and consumed in Quebec up to a capped ammount.	
Renewable Fuels Incentive	March 23, 2006		Tax refund of $0.162/L on the purchase of pure (B100) biodiesel fuel (> 3000 L) that is not blended with any other type of fuel (provided the biodiesel is consumed in Quebec).	
NOVA SCOTIA				
Renewable Fuels Incentive	July 1, 2006		Motive fuel tax exemption of $0.154/L for biodiesel produced in Nova Scotia (biodiesel portion of blends only) that meets the American Society for Testing and Materials fuel-quality specification.	

Source: anonymous reviewer.

Table 5: Types of Government Support for Biofuels in Canada

Stage of Production	Nature of Support
Research and development	Grants and low interest loans
Business planning	Grants for feasibility studies and market development
Plant construction	Grants and low interest loans, accelerated depreciation
Production	Fuel tax exemptions, producer payments
Price support	Mandated biofuel blending requirements and tariffs
Distribution	Grants for storage and distribution infrastructure
Consumption	Tax breaks for the purchase of biofuel powered vehicles, government procurement and dissemination of information to consumers

Source: Laan et al. (2009).

Table 6: Biofuel Tariffs in Canada

Tariff Item	Description	MFN Tariff	Applicable Preferential Tariffs
2207.20.11.00	Ethyl alcohol, specially denatured, within the meaning of the Excise Act, 2001	4.92¢/litre	CCCT, LDCT, UST, MT, CT, CRT: free
2207.20.12.00	Ethyl alcohol, denatured, within the meaning of the Excise Act, 2001	4.92¢/litre	CCCT, LDCT, UST, MT, CT, CRT: free
2207.20.19.00	Ethyl alcohol, not denatured within the meaning of the Excise Act, 2001	12.28¢/litre	CCCT, LDCT, UST, MT, CT, CRT: free
2207.20.90.00	Ethyl alcohol, other denatured	6.5%	CCCT, LDCT, UST, MT, CT, CRT: free
3824.90.90.99	Miscellaneous chemical products, other, other, other (biodiesel)	6.5%	CCCT, LDCT, UST, MT, MUST, CIAT, CT, CRT: free GPT: 3%

Source: Canada Border Services Agency (2008).
The Most-favoured Nation tariff treatment (MFN) is extended to all countries with which Canada has a trading relationship and which are signatories to the General Agreement on Tariff and Trade (GATT).

The United States Tariff (UST), Mexico Tariff (MT) and the Mexico-U.S. Tariff (MUST) are all preferential tariff treatments under the North American Free Trade Agreement (NAFTA). The Chile Tariff (CT) is the preferential tariff treatment of the Canada-Chile Free Trade Agreement (CCFTA), the Canada-Israel Tariff (CIAT) is the preferential tariff treatment of the Canada-Israel Free Trade Agreement (CIFTA) and the Costa Rica Tariff (CRT) is the preferential tariff treatment of the Canada-Costa Rica Free Trade Agreement (CCRFTA).

The General Preferential Tariff (GPT), the Caribbean Commonwealth Countries Tariff (CCCT) and the Least Developed Country Tariff (LDCT) are tariff treatments unilaterally extended to countries that have unique geo-political or economic conditions to which the federal government in Canada has chosen to apply reduced rates of duties.

Table 7: Estimated Model Elasticities

	Elasticity
Ethanol Production (Equation 6)	
Real Net Profit (from Equation 5)	0.30
Lagged production	0.13
Share of Ethanol Fuel Consumption (Equation 2)	
Real Ethanol Price	-0.41
Real Gasoline Price	0.24
GASOLINE CONSUMPTION (Equation 3)	
Real Gasoline Price	-0.11
Real Ethanol Price	-0.04
GDP	0.13
Population	0.11
Net Imports of Ethanol	
Domestic/(Worldprice+tariff+transportation)	0.31

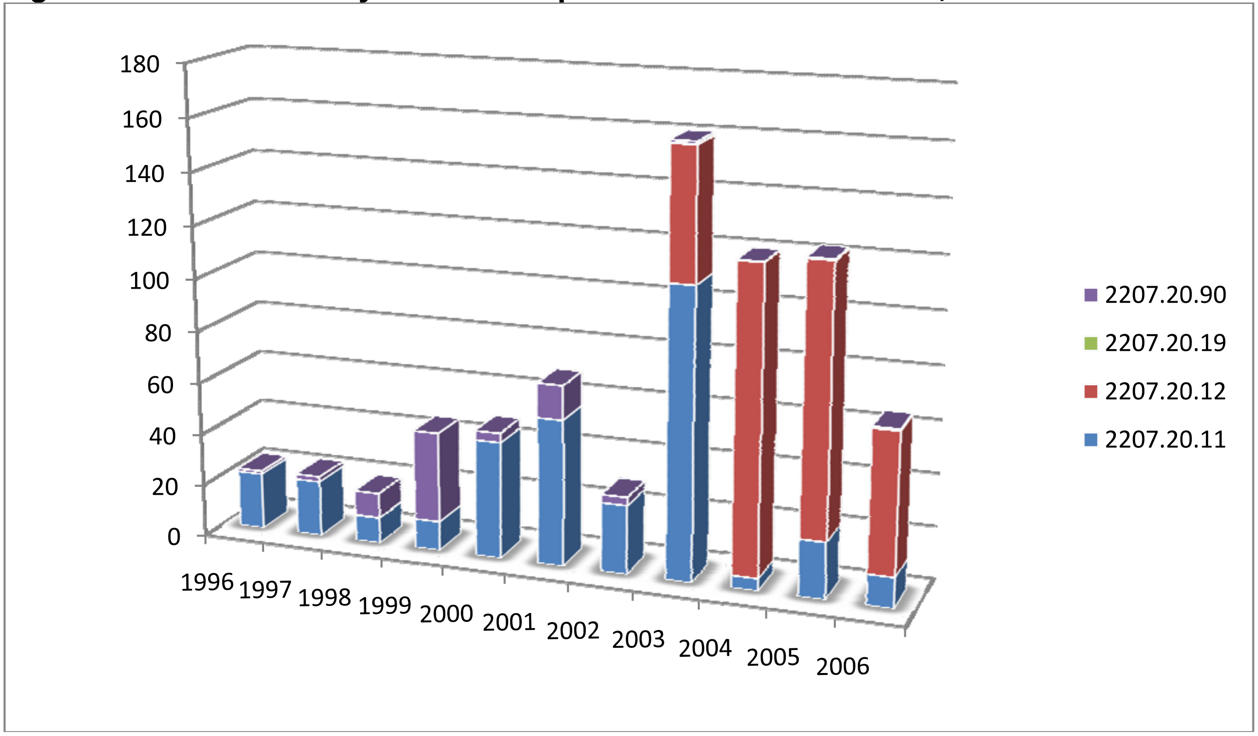
Table 8: Impacts of an Increase in Canadian Ethanol Demand, With and Without Trade Barriers, Static Analysis for 2011 (Million Litres)

Ethanol share of fuel consumption	Production	Consumption	Net Imports	Ethanol Price (C$/Litre)
5 percent	1343	2198	855	0.57
10 percent - Trade Barriers	3141	3996	855	1.13
10 percent -No Trade Barriers	1343	4211	2868	0.62

Table 9: Summary Results of Temporal Analysis: Estimated Canadian Ethanol Prices, Production, Consumption and Net Imports, 2006-2016

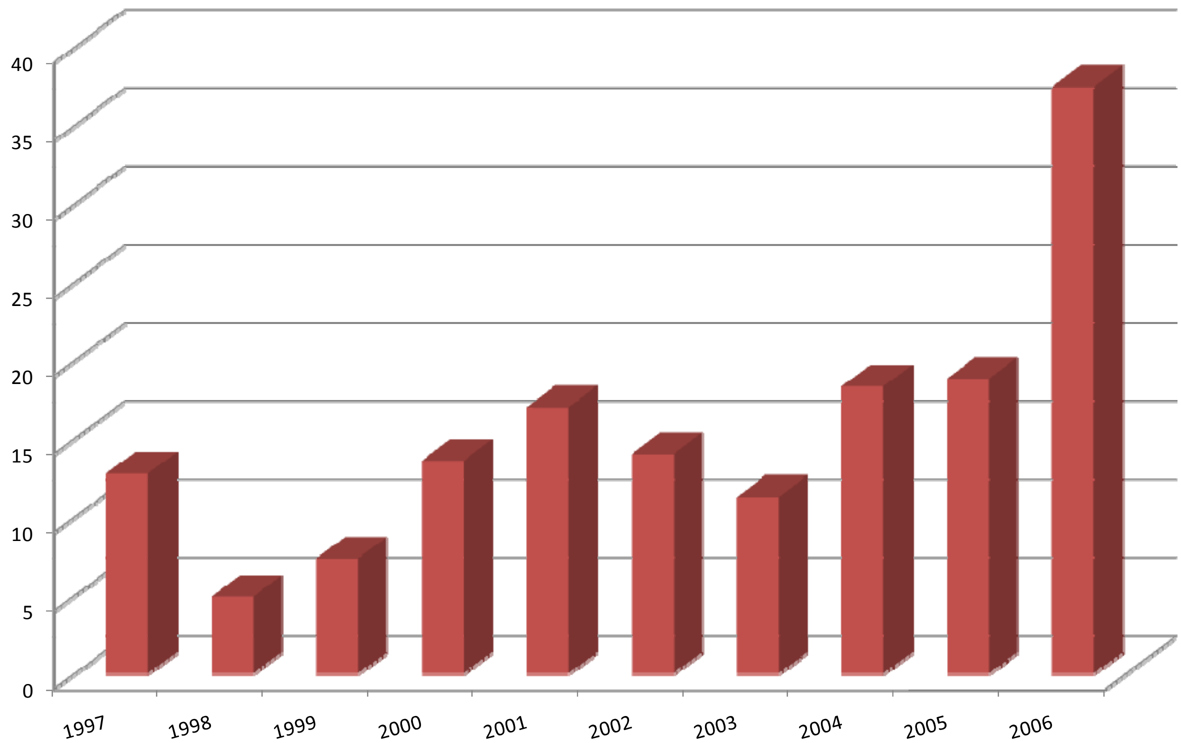
Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Avg.
Ethanol Price						**(C$/litre)**						
Baseline	0.59	0.72	0.72	0.72	0.70	0.66	0.62	0.59	0.56	0.54	0.51	0.63
Trade Barriers	0.59	0.62	0.79	0.92	1.08	1.25	1.12	1.04	0.96	0.85	0.74	0.88
No Trade Barriers	0.59	0.72	0.73	0.74	0.72	0.69	0.65	0.62	0.58	0.55	0.52	0.64
Production						**(millions of litres)**						
Baseline	337	313	584	851	1087	1343	1599	1857	2115	2349	2566	1466
Trade Barriers	337	339	1011	1665	2373	3141	3202	3245	3283	3289	3270	2482
No Trade Barriers	337	313	584	851	1087	1343	1599	1857	2115	2380	2597	1473
Consumption						**(millions of litres)**						
Baseline	380	783	1183	1599	1923	2198	2479	2768	3064	3373	3692	2306
Trade Barriers	380	810	1610	2414	3209	3996	4082	4156	4232	4313	4396	3322
No Trade Barriers	380	811	1634	2475	3335	4211	4254	4303	4354	4405	4463	3425
Net Imports						**(millions of litres)**						
Baseline	43	471	599	748	836	855	880	911	949	1025	1126	840
Trade Barriers	43	471	599	748	836	855	880	911	949	1025	1126	840
No Trade Barriers	43	498	1049	1625	2248	2868	2655	2447	2239	2025	1865	1952

Figure 1: Canadian Ethyl Alcohol Imports in Millions of Litres, 1996-2006



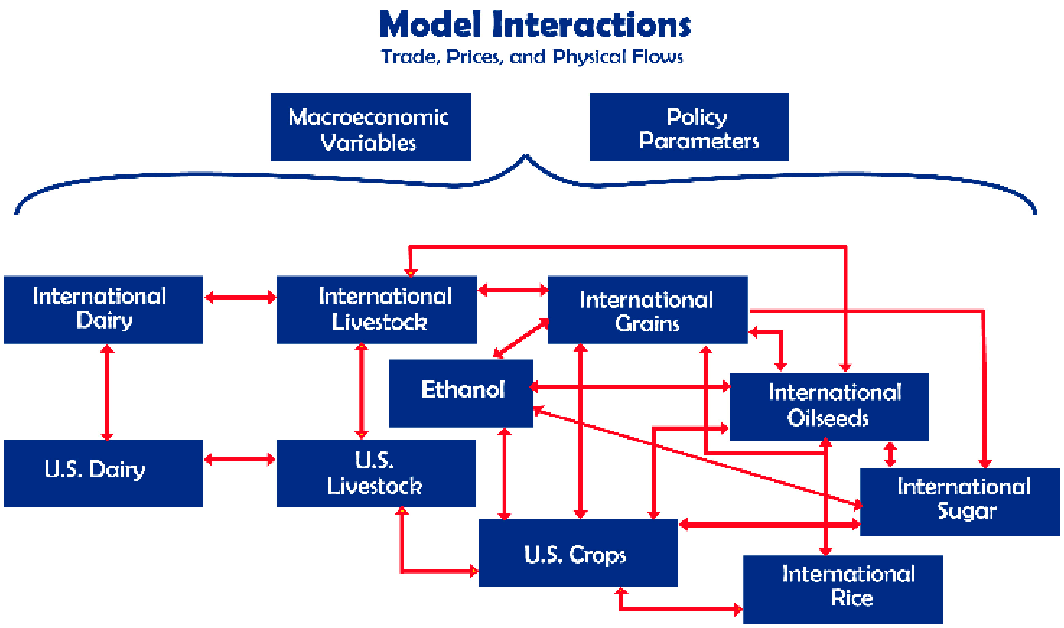
Source: Industry Canada (2007); Statistics Canada (2007b).

Figure 2: Canadian Exports of Denatured Ethyl Alcohol, Any Strength, in Millions of Litres, 1997-2006



Source: Statistics Canada (2007b).

Figure 3: The Structure of the FAPRI Model



Source: Elobeid and Tokgoz (2006).

Figure 4: Maintained Assumptions about Increased Consumption of Ethanol

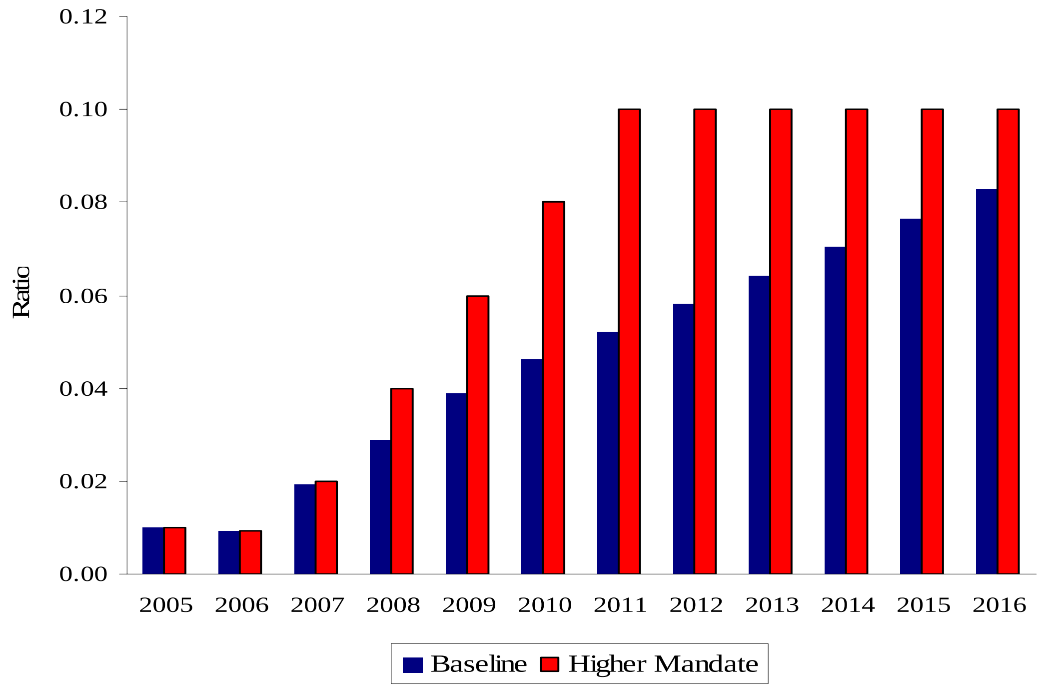


Figure 5: Impacts of an Increase in Canadian Ethanol Demand, With Increased Trade, on the World Ethanol Price (Scenario 1)