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BIOFUELS DEVELOPMENT STRATEGY: A CASE STUDY OF THE DOMINICAN REPUBLIC

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EXECUTIVE SUMMARY

The Dominican Republic is well positioned to benefit from the development of an ethanol industry. It has adequate land resources and, under favorable market conditions, can produce ethanol cost-competitively for both domestic consumption and export.

Current market prices, however, have not been adequate to spur industry development. In these circumstances, the Dominican Republic government may wish to act to encourage the development of an ethanol industry. However, given the Dominican Republic's position as a country exempt from tariffs on exports of ethanol to the United States, one strategy the Dominican Republic should not pursue is an ethanol mandate. A mandate acts as an export barrier eliminating potentially valuable arbitrage opportunities between ethanol and gasoline. Furthermore, the environmental and energy security benefits of domestic ethanol consumption either do not apply to the Dominican Republic or are too poorly understood to justify mandated consumption.

As long as the Dominican Republic retains privileged access to U.S. and European ethanol markets, an export-led strategy ethanol development strategy will the greatest economic benefits. Even if ethanol becomes cheaper than gasoline, the Dominican Republic would still profit more by exporting domestic ethanol to the protected U.S. and EU markets, and importing cheaper ethanol at lower world prices.

The circumstances of the Dominican Republic are common to many developing nations considering biofuels development. The framework approach used in this paper and its conclusions may be applicable to biofuels initiatives in other developing nations.

TABLE OF CONTENTS

Introduction

Biofuels have often been presented as a tool to address the economic, environmental, and social ills of developing nations.[2] However, barring Brazil, no developing nation to date has successfully pursued these benefits on a large scale. Indeed, many questions remain on when and how biofuels development should be pursued.

The Dominican Republic appears to be an excellent candidate for biofuels development, specifically sugar cane ethanol. In June of 2007 the U.S.-Brazil Biofuels Partnership, an initiative within the International Biofuels Forum, selected the Dominican Republic as a target country. Studies through this initiative will assess the potential for biofuels production, the policy environment, and the feasibility of specific projects.[3]

An initial assessment of the Dominican Republic's potential for biofuels development appears promising. The climate is ideal for sugarcane cultivation, and the sugar industry has a long, if tumultuous, history in the Dominican Republic. The collapse of the industry during the 1980s resulted in tens of thousands of acres of idle "cane lands" and increased rural poverty, both of which could be addressed by revived sugar production. Further, the nation is entirely dependent on imported fossil fuels. When oil prices rise, the cost of imported fuels increases domestic production costs and the country's current account deficit. Hence substituting cost-competitive biofuels for imported oil could have macroeconomic benefits.

The Dominican Republic's physical suitability for ethanol production, however, is only one piece of the puzzle—the potential for developing an ethanol industry can only be assessed properly in the context of potentially complex hemispheric trade dynamics. On the one hand, the Dominican Republic's privileged trade relationship with the United States supports the price of Dominican sugar, raising to some extent, the opportunity cost of ethanol production in the Dominican Republic. On the other hand, in contrast to Brazil, the Dominican Republic has tariff-exempt access to the U.S. ethanol markets, where prices in 2009 are artificially inflated by U.S. consumption mandates.

[2] A classic example of this is the main policy document for the Dominican Biofuels initiative, "Proyecto de Mezcla Etanol Carburante/Gasolina (E5-E25). SEIC. 2006."
[3] "Addressing Energy Issues in the Western Hemisphere." Press Release. US State Department. August 4, 2008.

This paper poses and attempts to answer a number of key questions on biofuels production in the Dominican Republic specifically, and on biofuels development strategy more broadly using the Dominican Republic as a case study. Section one provides necessary background on the Dominican sugar industry and the movement toward biofuels. Section two addresses the question: Does it make economic sense for the Dominican Republic to develop a biofuels industry? Without sufficient land resources or cost-competitive biofuels production, a biofuels industry could become a sinkhole for government subsidies, or worse, a disruption to economic development. Following a qualified affirmative conclusion to section two, section three examines the question: What strategy should the Dominican government use to promote biofuels development? Is export-led growth the correct path, or is the creation of an internal market through a biofuels mandate preferable?

Many of the questions faced by the Dominican Republic with respect to sugar cane ethanol are common to developing nations seeking to establish their own ethanol industries, particularly in Central America. It is hoped that this commentary will shed light not only on the Dominican experience, but also on biofuels development strategy across the region.

1. Dominican Context

Until recently there has been little investment or policy activity in biofuels in the Dominican Republic. However, in May of 2007, the new renewable energy law, "Of Incentives for Renewable Energy and Special Regimes," established a raft of tax incentives for cane ethanol and other renewables.[4] The *reglamento*[5] for this legislation was finally released in May of 2008, laying out in detail regulations for the new ethanol industry and an ethanol consumption mandate.[6]

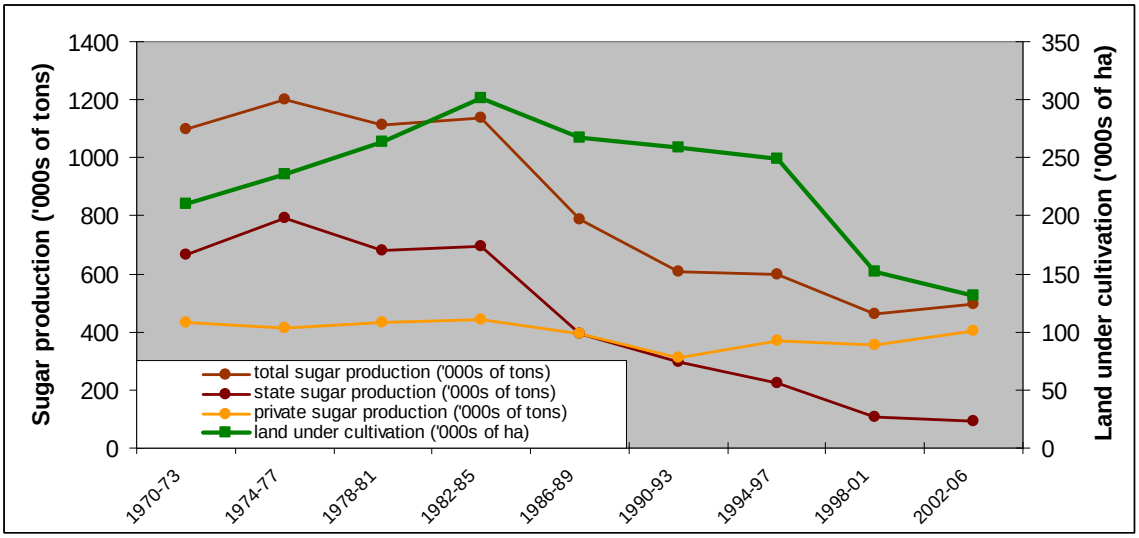
[4] Among the more significant provisions are an exemption for the fuel excise tax for fuel ethanol, a 10 year income tax holiday for renewable energy sales, and 75% tax credit for industrial and residential investment in renewable energy autoproduction. This last measure applies to bagasse-cogeneration at ethanol plants.
[5] The *reglamento* is a document issued by the administration which provides details on the execution of legislation, somewhat similar to an executive order.
[6] Reglamento of Law No. 57-07. Number 202-08. Government of the Dominican Republic. May 30, 2008.

The foundation for Dominican cane ethanol will be the sugar industry. Currently the Vicini and Fanjul families dominate sugar production through ownership of the Cristóbal Colón, CAEI, and Central Romana *ingenios*,[7] respectively. Barahona, a medium sized mill, is run by a group of French and American Investors.[8] The remaining *ingenios* are owned by the State Sugar Estate (CEA, by its Spanish initials), which was created to manage the Trujillo family sugar assets. These properties were taken over by the state after Trujillo's death. Additional cane lands are owned by *colonos*, or independent cane farmers who contract with an *ingenio* to sell their production.[9] It is estimated that combined the *colonos* have roughly 60,000 hectares of land, and that roughly 30% of their production is purchased by large integrated *ingenios*[10]

The Dominican sugar industry is currently recovering from a steep decline. Production of raw cane rose slightly to 5.2 million tons in 2006, but was down from a peak of 11.8 million tons in 1982. Land harvested has similarly fallen from a peak of 234,000 ha in 1993 to an estimated 100,000 ha in 2006.[11] The decline of the sector is broadly attributed to falling sugar prices, changes in the U.S. quota, poor management of CEA lands, and the stalled CEA privatization process.[12] While the Vicini and Fanjul *ingenios* have maintained strong production levels, invested and modernized their facilities, the CEA lands are largely in disrepair. Only 1 of 8 remaining CEA *ingenios* is active.[13] Predictably, the role of the CEA has diminished; from 1980 to 2005 the share of CEA sugar in the Dominican industry fell from over 60% to just under 15%.[14]

[7] An ingenio is a sugar mill with associated sugarcane lands.
[8] "Productores/Ingenios." Inazucar. www.inazucar.gov.do
[9] Chardon, Ronald. "Sugar Plantations in the Dominican Republic." *Geographica Review*. Vol. 74, No. 4 (Oct., 1984), pp 448-449.
[10] Johanna Mendelson-Forman. Center for Strategic and International Studies, Senior Associate. "Energy and Security in Latin America." Testimony Presented to the Senate Committee on Foreign Relations. June 22, 2006. Page 7-8.
[11] FAOSTAT.
[12] Johanna Mendelson-Forman. Center for Strategic and International Studies, Senior Associate. "Energy and Security in Latin America." Testimony Presented to the Senate Committee on Foreign Relations. June 22, 2006.
[13] Ibid.
[14] "Perspectiva de la Industria Azucarera en el Marco del DR-CAFTA." Faustino Jimenez. Presented at the 25th General Assembly of the International Sugar Organization. November 21-25 2005, London.

Figure 1: Historical Evolution of the Dominican Sugar Sector[15]



Production by the Dominican sugarcane industry is relatively inefficient. In 2006 the average yield was estimated by the FAO at 51.6 tons of cane per hectare. This is much improved from the historical low of 23.7 tons per hectare in 1995, but lags substantially behind other major producers in the Caribbean basin, with yields estimated from 70 to nearly 100 tons per hectare.[16] Given that the Vicini and Fanjul operations are modern and well-financed, it is likely that this low number is attributable to poor management of cultivated area of the CEA and *colono* lands.

The main reason that Dominican sugar has survived this dismal performance is privileged access to the U.S. sugar market. Tariff free access to this market was first introduced during the Balaguer presidency (1966-1978) as a form of economic aid in order to stabilize the nation's political situation. In 2008 the a tariff rate quota (TRQ) allowed Dominican sugar exporters to sell up to 185,300 metric tons of sugar to the United States at its protected price,[17] which is far higher than the world price. As of December 2008, the U.S. raw sugar price was seven and half cents per pound higher than

[15] La Nueva Politica Azucarera Dominicana de Cara al Desafio Internacional." Faustino Jimenez. Presented at the 31st General Assembly of the International Sugar Organization. May 29-31, 2007. Mauritius. Pages 12-13.
[16] Food and Agricultural Organization Statistics.
[17] "USTR Announces FY 2008 Tariff-Rate Quota Allocations for Raw Cane Sugar." United States Trade Representative. August 17, 2007. Accessed online at http://www.ustr.gov/Document_Library/Press_Releases/2007/August/USTR_Announces_FY_2008_Tariff-Rate_Quota_Allocations_for_Raw_Cane_Sugar.html

the world price, a premium of over 60%.[18] Ironically, the TRQ also appears to be a driver for continued low levels of Dominican sugar production. From 1982-1985 the Dominican Republic could export roughly 500,000 metric tons per year to the United States tariff-free, about half as much on average over the next ten years. Subsequently, the TRQ fell to current levels.[19]

The state has a heavy hand in maintaining the stability of the sugar market. Production by major *ingenios* is nominally authorized by the state. Export quotas are distributed by the state between major producers. In 2009 about 60% of the export quota was granted to Central Romana, 30% to Colon, and 10% to the Barahona *ingenio*.[20] Imports are also subject to approval by Inazucar, the sugar industry regulatory body. Finally, maximum domestic producer, wholesale, and retail sugar prices are established by the state as well.[21] However, price limits appear to be ineffective, as reported retail prices are often higher.[22] According to rough estimates based on Inazucar data, typical producer revenues were around 20 cents per pound domestically, and 21.4 cents per pound for export in 2008 (in line with US raw sugar prices). Government regulation seems to constrain imports to the Dominican Republic, which cost only 17.4 cents per pound in 2008 (roughly in line with world refined sugar prices).[23]

Currently the Dominican government is seeking to revitalize the sugar industry by "capitalizing" the remaining CEA assets through long-term leases to ethanol producers.[24] While the details of most of these deals which are currently being negotiated are not public, one recent agreement stipulated a 30 year lease term on lands associated with a new ethanol mill.[25] A number of high profile ethanol investment projects have been

[18] "Sugar and Sweeteners: Data Tables." Table 3 and Table 4. USDA ERS. Accessed online at http://www.ers.usda.gov/Briefing/Sugar/Data.htm
[19] "Sugars and Sweeterners Yearbook."
[20] "Decreto Zafra 2009" Lionel Fernandez. 2009.
[21] "Resolucion 01/2006" Instituto Azucarero Dominicano. http://www.inazucar.gov.do/res_no01-2006.htm
[22] Maximum retail prices range from 0.31-0.35 USD per pound of sugar, while in June 08 an Inazucar survey found them from 0.37-0.41 USD per pound.
[23] Prices based on estimated industry earnings and volumes for sugar exports and domestic sugar sales. Includes both raw and refined sugar. Calculations based on Inazucar Annual Report, 2008. Available online at www.inazucar.gov.do/
[24] Decreto No 180-99. Lionel Fernandez. 1999.
[25] "Nuevo impasse limita renta de los ingenios." *Listin Diario*. July 30, 2008. Accessed online at http://www.listindiario.com/app/article.aspx?id=67902

announced, including Alco-Group at Gubatico *ingenio*,[26] Etanol Dominicana and CTD at Boca Chica *ingenio*,[27] Forbes at Manzanillo, Sante Fe, and Porvenir *ingenious*,[28] and URS Corporation and RJS Group at Monte Plata.[29] To date only the RJS Group has made tangible process, preparing land needed for feedstock cultivation.[30]

Dominican efforts to develop an ethanol industry have received substantial international support, most notably in the form of market access. In 2007 tariff-free access to the US market was confirmed when the Dominican Republic ratified DR-CAFTA (previously tariff free access was provided through the Caribbean Basin Initiative),[31] and the Contonou agreement of 2000 secured tariff-free access to the EU.[32] Even if Dominican ethanol becomes very successful, it is likely that these trade privileges will continue. The volume of ethanol that the Dominican Republic could theoretically produce is a drop in the bucket compared to US production, and only about 25% of 2008 imports into the United States.[33]

2. Does a biofuels industry make economic sense?

In order for ethanol development the Dominican Republic to have a chance at economic viability, the Dominican Republic must 1) have sufficient land resources to produce biofuels, and 2) be able to make ethanol cost-competitive with gasoline domestically, or with ethanol within export markets.

[26] "Inversionistas ven el etanol como negocio con futuro." Comision Nacional de Energia. Noticias. http://www.cne.gov.do/Page.asp?key=57&export=html
[27] "Inversionistas inician proyecto de US$200 millones para etanol." *Diario Listín*. December 5, 2006.
[28] "Dominican Republic: Executive Summary." Forbes company webpage. Accessed Feb. 14, 2008 at www.forbesgroup.us
[29] "Hay US$200 MM para que RD lidere la producción de etanol." *Listín Diario*. September 3, 2007.
[30] "Many want to invest in Dominican energy projects, few materialize." *Dominican Today*. May 25, 2009.
[31] "Con entrada en vigencia DR-CAFTA creceran exportaciones de agro." *Hoy Digital*. March 2, 2007.
[32] ACP-EU-trade.org. "Frequently asked questions." Downloaded August 14, 2009.
[33] If the Dominican Republic were to use all cane lands for ethanol production they would produce an estimated 159M gallons (see following analysis), compared to 2008 ethanol production of 9B gallons in the United States and total imports of 600M gallons (Renewable Fuels Association 2009 Ethanol Industry Outlook).

2.1 Land Resources

While it lacks the land resources of Brazil, or even Cuba, the Dominican Republic is well positioned to become a medium-sized biofuels producer. Central to this ethanol potential are the tracts of 'cane lands' left by the collapse of the Dominican sugar industry.

Available Land Resources and Cane Production

Numerous sources state that vast tracts of traditional cane lands could be dedicated to cane ethanol without affecting current food production, though the quantity of land is somewhat unclear. The Food and Agriculture Organization Statistics Division (FAOSTAT) suggest that there are roughly 235,000 hectares of traditional cane lands, of which 100,000 actively used. A 2006 State Secretariat of Industry and Commerce (SEIC in Spanish) analysis stated total cane lands were 273,000 hectares, with 196,000 actively used.[34] The SEIC also states that an additional 100,000 hectares of idle agricultural land could used for cane production, bringing the total to 373,000 hectares. Finally, a 2007 Inter-American Development Bank report, citing FAO data, estimated traditional cane lands at 350,000 ha, with 200,000 hectares available for ethanol production without disrupting food production.[35] A forthcoming study prepared for the U.S.-Brazil Biofuels Partnership should put this question to rest, but for the purpose of this analysis, the IADB figure of 200,000 will be used.

The Dominican Republic has an interest in fulfilling its tariff rate import quota (TRQ) to the United States, which was 185,300 metric tons in 2008.[36] This import quota is determined by the US Trade Representative, which assigns a portion of a general TRQ to various countries on an annual basis.[37] A systematic failure to fill the quota by an exporting country could result in part of the share of the general TRQ being granted to another country. However, assuming reasonable yields, only 28,000 hectares of land

[34] "Proyecto de Mezcla Etanol Carburante/Gasolina (E5-E25). SEIC. 2006. Pages 17-18.
[35] "A Blueprint for Green Energy in the Americas." Inter-American Development Bank. 2007. Page 143.
[36] "USTR Announces FY 2008 Tariff-Rate Quota Allocations for Raw Cane Sugar." United States Trade Representative. August 17, 2007. Accessed online at http://www.ustr.gov/Document_Library/Press_Releases/2007/August/USTR_Announces_FY_2008_Tariff-Rate_Quota_Allocations_for_Raw_Cane_Sugar.html
[37] Stephen Haley and Mir Ali. "Sugar Backgrounder." USDA Economic Research Service. [SSS-249-01] July 2007. Pages 27-28.

would be needed to fill the Dominican quota.[38] This is less than half than the combined territories of the Vicini and Fanjul holdings[39] and would leave up to 172,000 hectares for biofuel production available based on the IADB estimate of total available cane lands.

It should be noted that the *reglamento* prohibits the use of agricultural lands for cultivation of energy crops.[40] Therefore, growing cane for ethanol on land that previously grew cane for sugar could run into legal obstacles. However it is unclear how this regulation will be enforced, particularly as cane can be used to make sugar or ethanol, and it is hard to determine the ultimate use a priori.

Potential Production

Assuming that a revived and modernized sugar cane industry could produce yields of 60 tones per ha and that each ton of cane yields 75 liters of ethanol, the theoretical maximum ethanol yield from traditional cane lands not used for food cultivation would be approximately 900 million liters, or 237 million gallons (the energy equivalent of 159 million gallons of gasoline).[41] By reference, 2005 gasoline consumption in the Dominican Republic was roughly 297 million gallons.[42] Clearly, without a large fleet of flex fuel vehicles this is more ethanol than the Dominican Republic could consume in the near future.[43] Therefore if the Dominican Republic produced even at a percentage of its theoretical capacity, it would have to sell a significant portion of it on the export market. Again, using 2005 numbers as a benchmark, if the Dominican Republic were to displace 10 percent of its gasoline consumption by volume (29 million gallons), roughly 208 million gallons of ethanol would be available for export. If 20% of gasoline consumption

[38] Assuming a yield of 60 tons per hectare, mill efficiency of 90%, and TRS value of 12%, only 28,500 hectares would be required to produce 185,000 tons of raw sugar.
[39] According to Inazucar the La Romana has 43,000 ha of cane lands under cultivation, and CAEI and Colon (the Vicini ingenios) combined have roughly 18,000.
[40] Reglamento of Law No. 57-07. Number 202-08. Article 129. Government of the Dominican Republic. May 30, 2008.
[41] Assumes 200,000 ha per analysis above and that ethanol contains 67% the energy of an equal volume of gasoline. Both cane and ethanol yield numbers are estimates chosen as representative of typical ethanol operations based on the SEIC study of Dominican ethanol.
[42] It is assumed that nearly 100% of this fuel is used for transport. "Proyecto de Mezcla Etanol Carburante/Gasolina" (E5-E25). SEIC. 2006. Page 11.
[43] No data is available on the size of the Dominican flex fuel vehicle fleet, but it is assumed to be small in the absence of any government policy to encourage flex fuel technology adoption and low vehicle fleet turnover.

by volume were replaced (the level at which tax exemptions automatically cut off),[44] 178 million gallons of ethanol would remain, yielding roughly 270 million USD in revenues, assuming a conservative netback price of 1.50 USD per gallon.[45]

The Dominican Republic does not have a strong capital market. Thus potential biofuels producers would have to seek funds abroad. Based on the investment needs identified by the SEIC ethanol analysis, a new ethanol plant with annual capacity of 229 million gallons would cost roughly 620 million USD, or a capital cost of roughly 2.60 USD per gallon of capacity.[46] This is the equivalent of 36 percent of FDI in the Dominican Republic in 2007, and 1.7 percent of GDP.[47] A large additional investment would be needed to expand cane production. Therefore, obtaining needed capital will be a major challenge, even in capital markets that are much more liquid than those today.

2.2 The Cost Competitiveness of Dominican Ethanol

In addition to land resources, the key question about the viability of Dominican ethanol is: will it be cost-competitive? This section reviews estimates for ethanol cost of production in the Dominican Republic and in competing markets, as well as prevailing market prices. Additionally, tax and tariff regimes are considered, though in the long-term an advantage in cost of production will do more to ensure the success of Dominican ethanol than potentially short-lived favorable trade agreements, tax breaks, or commodity price swings.

As demonstrated in recent months, market prices for biofuels are volatile. The peak and collapse of oil prices seen in 2008 had dramatic effects on the cost-competitiveness of biofuels in all markets. Thus, the market prices reported here should be taken as indicative of broader trends reflecting local production cost and global supply and demand rather than a precise indicator of Dominican ethanol's competitive potential.

[44] "Ley No. 57-07 de Incentivo a las Energias Renovables y Regimenes Especiales." Article 23. The National Congress of the Dominican Republic. May 7, 2007.
[45] For the reader's reference, at the time of writing the spot price for USGC anhydrous ethanol was 1.60 USD per gallon.
[46] The SEIC análisis estimates 188.6 million USD are needed for 72.3 million gallons per year, or 2.60 USD per gallon of capacity. By extension, 159 million gallons per year would require (159 * 2.60 =) 414 million USD in investment. Note that the SEIC investment estimate is spread over five years.
[47] World Development Indicators. Data from 2007.

Notably, Dominican ethanol prices will be regulated, but it is unclear at what level relative to world prices. For this reason a proxy of 1.60 USD per gallon[48] is used for the wholesale Dominican "market price" in this section.

In order for the Dominican Republic to benefit from an ethanol industry, the new fuel must be cost-competitive with: 1) the global ethanol price, 2) the local gasoline price, and 3) for exports, the EU or U.S. ethanol market price. If the cost of producing ethanol locally is higher than the global ethanol price, it makes more sense to simply import foreign ethanol than to produce it at home. If the cost of Dominican ethanol is higher than the price of gasoline (including externalities) the ethanol industry could become a costly import replacement program. And if the cost of Dominican ethanol is higher than market prices in the EU and United States, there will no potential export market. Also, in order to interest producers, the returns from growing sugar for ethanol need to be higher than those from simply making more sugar. If Dominican ethanol cannot become cost competitive by at least some of the measures listed above in the near to mid-term, the industry won't attract the capital it needs without substantial government support.

Cost Estimate for Dominican Ethanol

In 2006 the SEIC published an analysis of ethanol potential in the Dominican Republic based on four 20.5 million gallon per year (mpgy) ethanol mills which would displace 25% of domestic gasoline consumption, or 72.3 mgpy.[49] The study analyzed the economics of ethanol mills that incorporated bagasse[50] cogeneration, which uses bagasse as fuel for electricity generation. If bagasse cogeneration is included, the mills would produce 323 GWh of power annually,[51] the equivalent of 3% of electricity generated in the Dominican Republic in 2005.[52] The analysis assumed conservative cane yields

[48] 1.60 USD per gallon was identified by the SEIC as an ethanol wholesale price providing reasonable returns for producers. This value is substantially lower than other market prices over the observed period, but is not an unreasonable scenario if the Dominican government uses its power to limit returns to ethanol producers.
[49] The SEIC analysis calculates displacement by volume. Actual displacement would be less due to the lower energy content of ethanol. Some ethanol will remain for export once all four plants are running at full capacity (page 3, executive summary).
[50] Bagasse is the organic waste produced after removing cane juice from sugar cane.
[51] Based on implied value of 4.47 KWh per gallon. Reported in "Proyecto de Mezcla Etanol Carburante/Gasolina (E5-E25). SEIC. 2006. Page 31.
[52] Based on EIA value of 12.2b kilowatt hours generated in 2005. Dominican Republic Energy Profile

(beginning at 40 tons per hectare in 2005 and rising to 60 in 2010) and based cane cultivation costs on observed costs in Brazil.[53, 54] The SEIC projections for 2010 put the cost of anhydrous ethanol production (including feedstock costs) at 1.10 USD per gallon and estimated wholesale prices at 1.70 USD. If ethanol mills are built with bagasse cogeneration, the cost of production rises to 1.15 USD per gallon, and estimated wholesale price drops to 1.60 USD. However, the value obtained from selling a portion of the electricity reduces the net costs by 0.34 USD per gallon, resulting in a cost of 0.81 USD per gallon.[55] This estimate is probably optimistic – it is unlikely that the Dominican Republic could achieve the scale and cane yields needed to match Brazilian efficiency in the foreseeable future. A production cost range of 0.81 to 1.15 USD per gallon for Dominican ethanol will be assumed from this point on in this analysis. See Figure 2 below for a summary of SEIC cost and price estimates.

Figure 2: Ethanol cost of production and price by technology

Type of production	Cost of production	Estimated wholesale price
Ethanol only	1.10 USD per gallon	1.70 USD per gallon
Ethanol with bagasse cogeneration	1.15 USD per gallon (0.81 net of electricity revenues)	1.60 USD per gallon

Out of the total production cost of 1.15 USD per gallon for ethanol with cogeneration, processing costs (defined as all costs apart from feedstock) were estimated at roughly 0.45 USD per gallon.[56] The SEIC estimate of processing costs appears to be conservative, as other studies put the cost substantially lower.[57] If the revenues from cogeneration are subtracted from the 0.45 per gallon processing cost, the SEIC study yields a relatively low figure of 0.11 USD per gallon. Hence the feedstock costs will dominate the cost of building and operating an ethanol facility.

Financially, the SEIC analysis presents a reasonable scenario for investment (see Figure 3). The ethanol mills built with bagasse cogeneration were estimated to have an investment recovery period of 6-7 years with an internal rate of return of 21-24%, and

[53] "Proyecto de Mezcla Etanol Carburante/Gasolina" (E5-E25). SEIC. 2006. Page 19.
[54] See Appendix I for an explanation of SEIC assumptions.
[55] "Proyecto de Mezcla Etanol Carburante/Gasolina" (E5-E25). SEIC. 2006. Page 31-32.
[56] Processing costs were derived from the financial model accompanying the SEIC report by subtracting feedstock costs from total costs.
[57] Processing costs include all costs other that feedstock. "Analisis economico de precios del bioetanol para mezclas con gasolinas." CEPAL. 2006. Page 11-12.

under sensitivity testing for ethanol wholesale prices as low 1.50 USD per gallon, were found to be strongly NPV positive in all scenarios.[58]

Figure 3: Ethanol Investment Scenarios by Wholesale Price[59]

Ethanol sale price (at the mill gate), USD/Gallon	**1.60**	**1.55**	**1.50**
Ethanol Production, Millones of ga. / year	20.4	20.4	20.4
Excess energy produced, Mwh/year	289,752	289,752	289,752
NPV a 12%, Millons USD	**47.0**	**41.6**	**36.5**
Internal Rate of Return (IRR) %	**23.69%**	**22.14%**	**20.71%**
Time to Recovery of Investment, years	**6.3**	**6.9**	**7.6**

Note: Numbers refer to the fifth year of each scenario

The Global Ethanol Price

If Dominican ethanol cannot be produced below the global ethanol price in the near term it would be more efficient to simply import ethanol, assuming that it is available. Much like the world price for oil, the global price of ethanol is more concept than reality. The international ethanol market is still small, consisting of only about 10% of global production, with 48% of exports originating in Brazil.[60] As a result, this analysis uses the Brazilian spot market price as a proxy for the world price. As the world's largest ethanol producer and exporter, in a global market, Brazil would likely set the world price, similar to the role of Saudi Arabia in world oil markets. The spot price is a better proxy than producers prices because it indicates at what point Brazil will actually export ethanol to the world market. From June to December 2008,[61] the average spot ethanol price in Sao Paolo, the major Brazilian ethanol market, was 2.00 USD[62] per gallon, 0.40 USD higher than the Dominican wholesale price estimated by the SEIC. However, Brazilian prices include significant rents –both for the producers and the governments. Brazilian cost of production is much lower; in 2006 the USDA estimated the cost of production for Brazilian ethanol at 0.81 USD per gallon,[63] matching the lowest, and rather optimistic, SEIC cost of production estimate for Dominican ethanol. It is not difficult to imagine a

[58] "Proyecto de Mezcla Etanol Carburante/Gasolina (E5-E25). SEIC. 2006. Pages 33-35.
[59] Ibid.
[60] Arnaldo Walter et al. "Perspectives fuel ethanol consumption and trade." *Biomass & Bioenergy*. Vol. 32. 2008. Pages 744-745.
[61] This is a six month average price from June 7, 2008 to December 7, 2008. All market prices reported in this article reflect this same time frame. See Appendix II for a full listing of the prices used in this analysis
[62] Sao Paulo anhydrous ethanol spot price. Bloomberg. This price is for Domestic ethanol (3.6% consumption taxes already paid for).
[63] "The Economic Feasibility of Ethanol Production from Sugar in the United States." USDA. July 2006. Summary and Conclusions, Page iv.

scenario where Brazilian wholesale prices are lower than Dominican prices. Indeed, at the time of writing Brazilian ethanol was already trading at 1.50 USD per gallon, following the global collapse of oil prices. If the Brazilian wholesale price falls further and remains low, it would be more cost-effective to import Brazilian ethanol than produce it in the Dominican Republic.

The Local Gasoline Price

The price of gasoline in the Dominican Republic is relatively high, mainly due to consumption taxes. The nation produces about 25% of its fuel at the state-owned refinery, REFIMDOSA, importing the rest.[64] Gasoline prices are officially regulated by the SEIC using "import parity prices" (PPI by its Spanish initials), which are updated weekly. To arrive at the PPI, SEIC sums various costs of importing gasoline to the Dominican Republic based on the FOB U.S. Gulf Coast price as reported in Platt's Oil and Gas. Regulated wholesale and retail margins and taxes are then added to the PPI to arrive at a mandated consumer price.[65]

The *reglamento* establishes a similar mechanism to be used to regulate the consumption price of ethanol, but instead of using the PPI alone, the PPI is averaged with an international ethanol price and summed with a generic compensation factor. This compensation factor is meant to capture the positive (or negative) externalities associated with biofuels consumption and guarantee long-term ethanol industry profits. Gasoline-ethanol blends at the pump are priced using a weighted average of the regulated prices for gasoline and ethanol.[66] For example, if the international price of ethanol is 2.00 USD per gallon, the domestic PPI ethanol price is 2.50 USD, the gasoline PPI price is 2.00 USD, and the compensation factor is 0.20 per gallon, the price of a 10% gasohol blend at the pump net of taxes would be roughly 2.05 USD per gallon.[67] The *reglamento,* additionally

[64] "Refineria Dominicana de Petoleo S.A.: Perfil de Empresa." Business News Americas. August 8, 2008. Accessed online at http://www.bnamericas.com/company-profile/es/Refineria_Dominicana_de_Petroleo,_S,A,-Refidomsa

[65] "Una Formula Poco Comprendida." *El Caribe*. September 4, 2005. Accessed online at www.elcaribe.com.

[66] "Ariticulo 24: Del Regimen Retrubitivo de los Biocombustibles." Ley 57-07.

[67] This is the average of the international biofuels price and the biofuels PPI, plus the compensation premium times 10% (for a ten percent ethanol blend) plus 90% of the gasoline PPI, or ((2.50 + 2.00)/2 + 0.20) * 0.10 + 2.00 * .9 = 2.045.

stipulates that the ethanol wholesale price cannot exceed the ethanol PPI.[68] The effect of this policy is twofold: 1) to keep local producers, distributers, and importers from price gouging, and 2) to ensure reasonable returns to these same players. The *reglamento* also restricts exports unless domestic demand (at regulated prices) is met,[69] creating the possibility of a sustained difference between domestic and international prices.

Ultimately, taxes levied on gasoline consumption give ethanol a strong price advantage in the Dominican Republic. Based on the SEIC price estimates above, and Dominican gasoline prices from June through December 2008, ethanol would have a 1.79 USD per gallon price advantage over gasoline on the Dominican market, after adjusting for lower energy content. If gasoline enjoyed the same tax exemptions as ethanol, this price advantage would narrow to 0.17 USD. Figure 4 below displays estimated consumer price components for both ethanol and regular gasoline.

Figure 4: Comparative Cost at the Pump of Ethanol and Gasoline for the Dominican Republic (USD/gallon)[70]

Ethanol price at the Pump		**Regular gasoline price at the pump[71]**	
SEIC estimated wholesale ethanol price	1.60	Regular gasoline import parity price	2.68
Value added tax (16%)	Exempt	Value added tax (16%)	0.43
Gasoline tax	Exempt	Gasoline tax (indexed to CPI)	1.19
Assumed distributor's margin	0.11	Distributor's margin (2.4%)	0.11
Assumed retailer's margin	0.36	Retailer's margin (12.1%)	0.36
Transport Commission	0.09	Transport Commission	0.09
Final Retail Price…	2.16	Final Retail Price…	4.87
…at Energy Parity	3.08	…at Energy Parity	4.87

Note: Gasoline totals do not sum exactly due to rounding.

While a cost advantage driven by tax treatment raises questions about the economic efficiency of domestic ethanol consumption, barring changes in the Dominican fuel tax regime or a sustained reduction in oil prices (at the time of writing the retail price for regular gasoline was down to 3.28 USD), it is likely that Dominican ethanol would be competitive with gasoline on the domestic market.

[68] Reglamento of Law No. 57-07. Number 202-08. Article 212. Government of the Dominican Republic. May 30, 2008.
[69] Reglamento of Law No. 57-07. Number 202-08. Article 227, paragraph II. Government of the Dominican Republic. May 30, 2008.
[70] Analysis assumes that regulated distributors' and retailers' margins will be identical for ethanol and gasoline. Ethanol is assumed to have 67% the energy content of ethanol. An exchange rate of 35 Dominican pesos to one USD is assumed.
[71] Average of weekly PPI reported in from June through December 2008. "Aviso precios combustibles." SEIC.

Price Competition on Export Markets

Dominican ethanol appears well placed to compete in both the EU and the United States despite recent low ethanol prices on both markets. This section briefly reviews recent spot prices in these markets, ethanol production cost estimates, transportation costs, and import duties. Market prices will determine how profitably Dominican ethanol can be exported, but production costs provide the best indicator of the comparative advantage held by Dominican ethanol relative to local production in the United States and EU.

Geographic proximity and an ambitious ethanol consumption mandate[72] make the United States the most logical export market for Dominican ethanol. Recent spot prices of fuel ethanol in the United States averaged 2.25 USD per gallon on the Gulf Coast.[73] Based on the SEIC estimates this would leave a margin of roughly 0.65 USD per gallon on U.S. markets, easily enough for a healthy profit after freight charges are accounted for. However, the EIA forecasts ethanol market prices for at 1.79 USD per gallon in 2010, and 1.33 per gallon in 2015.[74] Indeed, USGC ethanol at the time of writing was down to 1.60 USD per gallon, emphasizing the vulnerability of Dominican ethanol to price volatility on export markets.[75]

Cost of production estimates for the United States are ambiguous. In July 2006, USDA estimated the cost of production for U.S. corn ethanol at 1.05 USD per gallon. Roughly 50% of this sum went to feedstock.[76] At the time of this estimate a bushel of number 2 corn cost roughly three dollars per bushel on the CBOT stock market. This price spiked to nearly six dollars in summer of 2008, before falling sharply in recent months. With corn at six dollars a bushel, the cost of production of U.S. ethanol would rise to an estimated 1.57 USD per gallon. Thus, during summer 2008 Dominican ethanol had a clear advantage in cost of production, but by summer 2009 this was no longer the case.

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[72] The 2007 Energy Security and Independence Act renewable fuels standard mandates 36 billion gallons of biofuels consumption, 21 billion of which must be "advanced biofuels" (this category includes cane ethanol).
[73] USGC Spot Ethanol. Bloomberg. Average price from June through December 2008.
[74] "2008 Annual Energy Outlook." Table 1. Energy Information Agency. June 2008. Accessed online at http://www.eia.doe.gov/oiaf/aeo/aeoref_tab.html
[75] USGC fuel ethanol spot price. Bloomberg.
[76] "The Economic Feasibility of Ethanol Production from Sugar in the United States." USDA. July 2006. Summary and Conclusions, Page iii.

Notably, potential changes in the policies which support the U.S. corn ethanol industry introduce even greater uncertainty. A reduction in import tariffs on Brazilian ethanol would create a more competitive market, reducing the opportunity for Dominican producers to capture rents generated by the U.S. ethanol mandate. While a reduction in the billions of dollars in subsidies that go to U.S. producers annually, could drive up corn ethanol prices, creating an even greater opportunity for imports.

The European ethanol import market is far shallower than its American counterpart. In the European Union ethanol spot prices averaged 2.72 USD per gallon in Rotterdam fob, including import duties.[77] If import duties are removed from this price the actual internal price would be 2.43 USD per gallon, suggesting that Dominican producers could profitably export to the EU after subtracting transport costs from gross margins of 0.83 USD.

Broadly speaking the EU does not produce cost-competitive ethanol, and perhaps as a result, consumes very little. Indeed ethanol accounted for only 16% of European biofuels consumption by energy content in 2006.[78] Production costs for European ethanol from sugar are estimated to cost from 2.91 to 3.33 USD per gallon and wheat from 2.68 to 3.06 USD per gallon[79], both well above the cost of producing Dominican ethanol. However, in the long-term the European market for imported biofuels is likely to focus on biodiesel rather than ethanol due to the high and growing share of diesel vehicles.

Ultimately, Dominican ethanol may need to compete with Brazilian ethanol in the United States, even though the market is presently protected by high tariffs. Barring import loopholes such as duty draw backs and offshore dehydration, to export Brazilian ethanol profitably in the United States, local wholesale prices must exceed domestic Brazilian prices by the size of the tariffs or, 0.54, plus freight rates of $0.16 USD

Figure 5 below displays the competitiveness of Dominican ethanol in various international markets based on recent spot prices, estimated transport costs and import duties. Figure 6 offers the same analysis based on ethanol cost of production.

[77] T1 Kingsman Spot Ethanol. Bloomberg. Average price from June through December 2008.
[78] "Biofuels Baramoter." *Systemes Solaires – Le Journal des Energies Renouvelables.* EuroObserver. May 2007. Page 65.
[79] "Biofuels for Transport." International Energy Agency. 2004. Page. 72.

Figure 5: Dominican and Brazilian Ethanol Competitiveness by Market Prices

Destination Market (local wholesale price)[80]	**Dominican Ethanol import price (USD/gallon)**	**Dominican Import price advantage (USD/gallon)**	**Brazilian Ethanol import price (USD/gallon)**	**Brazilian Import price advantage (USD/gallon)**
Dominican Republic (1.60 USD)	Not Applicable	Not Applicable	2.00 plus estimated 0.10 freight cost per gallon	Price disadvantage of 0.50
European Union (2.43 USD, import duty removed)	1.60 plus estimated freight cost of 0.26	Price advantage of 0.57	2.00 plus estimated 0.26 freight cost plus 0.29 duty.	Price disadvantage of 0.17
United States Gulf Coast (2.25 USD)	1.60 plus estimated freight cost of 0.10	Price advantage of 0.55	2.00 plus estimated 0.16 freight cost/gallon plus 0.54 duty.	Price disadvantage of 0.45

Figure 6: Dominican and Brazilian Ethanol Competitiveness by Cost of Production

Destination market cost of production (USD/gallon)	**Dominican ethanol cost of production (USD/gallon)**	**Dominican import cost advantage (USD/gallon)**	**Brazilian ethanol cost of production (USD/gallon)**	**Brazilian import cost advantage (USD/gallon)**
Dominican Republic (0.81-1.15)	Not Applicable	Not Applicable	0.81 plus estimated 0.10 freight cost per gallon	Roughly equal in price
European Union (2.68-3.33)	0.81-1.15 USD plus estimated freight cost of 0.26	Cost advantage of 1.27 – 2.26	0.81 plus estimated 0.26 freight cost plus 0.29 duty.	Cost advantage of 1.32 – 1.97
United States Gulf Coast (1.05-1.57)	0.81-1.15 USD plus estimated freight cost of 0.10	0.20 cost disadvantage to 0.66 advantage	0.81 plus estimated 0.16 freight cost plus 0.54 duty.	0.46 cost disadvantage to 0.06 per gallon advantage

[80] While ethanol is a commodity and in theory should sell at a single "world price", local prices vary because of transportation costs and tariff regimes. Dominican local prices are SEIC estimates. Wholesale prices for the United States and Europe are average spot prices as described in the text.

Sugar versus Ethanol Production

Privileged access to the U.S. sugar market has resulted in little interest in ethanol among traditional Dominican sugar producers. Indeed it appears that the existing industry can make more money from sugar alone, and without the added risk of a new product and a new market. This export market is limited by the tariff rate quota, 90% of which is filled by the Fanjul and Vicini sugar mills.[81] The limits of the U.S. sugar quota suggest that the Fanjul and Vicini families will not pursue ethanol production unless they are in a situation where their sugar production will consistently exceed export quotas. There may be greater incentive to pursue ethanol for new entrants and *colonos* who do not benefit from the U.S. TRQ.[82] However, ethanol development is unlikely if there is not a price premium on ethanol to its sugar equivalent. Currently ethanol production provides slightly inferior returns to those of sugar on the world market, and at higher U.S. prices as well.[83]

This is not the first time returns on sugar have caught up with those of ethanol. When world oil prices plummeted in the mid 1980s, ethanol prices fell in tandem. The Brazilian ethanol industry sharply contracted as mills switched production to sugar.[84] This scenario would not be economically damaging in the Dominican Republic as long as ethanol producers retained the flexibility to produce sugar as well. In the long run, increasing correlation between sugar and ethanol prices is likely to reduce this price risk even further.[85]

[81] 2009 export quota distribution.
[82] Johanna Mendelson-Forman. Center for Strategic and International Studies, Senior Associate. "Energy and Security in Latin America." Testimony Presented to the Senate Committee on Foreign Relations. June 22, 2006. Pages 7-8.
[83] As of December, 2008 global raw sugar prices were roughly 12.3 cent/lb. Based on theoretical ethanol conversion yields, the anhydrous ethanol indifference price (AEIP) can be calculated a: AEIP (liters) = 1.67 * World Sugar price (cents/kg), so 1.67*3.785 * 27.2 = 1.71 USD/gallon. (Costos y precios para etanol combustible en America central. CEPAL. 2006. Page 11). At the time of writing the price of USGC ethanol was 1.60 USD/gallon, meaning sugar slightly better returns.
[84] da Costa, M. A. et al. "Creating a Market for Etanol – Challenges Faced in the Brazilian Experience." Page 9.
[85] "Analisis Economico de Precios del Biuetanol para Mezclas con Gasolinas." United Nations, ECLAC. Page 7.

Summary: If ethanol prices are high, Dominican Ethanol is competitive.

In summary, based on the SEIC estimates Dominican ethanol will only be price competitive under favorable market conditions. On a cost basis it is never likely to under price Brazilian ethanol, though it may become cheaper to produce than U.S. corn-based ethanol due to the favorable economics of cane feedstock relative to corn. If the European market for ethanol expands, Dominican ethanol could benefit, but this is not likely to happen in the near and mid-term. Domestically, due to favorable tax treatment, ethanol has a cost advantage over gasoline, but ethanol production is unlikely until higher ethanol prices provide better returns than sugar.

3. Biofuels Development Strategy

Section two clearly shows that the Dominican Republic has the land resources to develop an ethanol industry and that under favorable conditions ethanol can be competitively produced both for the domestic market and for export. But what policy tools and regulatory strategy should the Dominican government use to ensure maximum benefit from this new industry? This section focuses on the tradeoffs between the use of an ethanol mandate to create a domestic market and a more open approach to ethanol trade.

3.1 Mandated Consumption versus Free Trade

The Renewables Law and the accompanying *reglamento* provide authority for an ethanol mandate, but leave the size of the mandate (percent ethanol blend by volume) at the discretion of the National Energy Commission (NCE by its Spanish initials). The NCE is supposed to set the blend requirement at a reasonable level in view of the nation's production capacity.[86] Only after meeting local demand are ethanol producers allowed to export their product. This, however, begs the question, how large should the ethanol mandate be? Should Dominican ethanol be reserved for domestic consumption, or would exports be preferable?

[86] Reglamento of Law No. 57-07. Number 202-08. Article 250. Government of the Dominican Republic. May 30, 2008.

Free trade proponents would argue that if producers in the Dominican Republic sell ethanol where they can receive the most value, in a macroeconomic sense the Dominican Republic would receive maximum benefit. For example, if Dominican ethanol is cheaper than ethanol overseas, the law of comparative advantage states that the Dominican Republic will benefit more by exporting ethanol and importing other goods than by requiring ethanol to be sold domestically rather than exported for a higher price.[87] Yet energy commodity markets are often characterized by global prices. In this case the highest returns are often found at home because transportation costs from the production site to consumption centers are lower,[88] suggesting that the Dominican Republic should meet domestic demand first, and export any surplus.

The underdeveloped and uneven state of the global ethanol market suggests that a more careful analysis of trade strategy is merited, particularly with respect to the economic health of the Dominican Republic. The following discussion reviews the tradeoffs between gasoline imports and ethanol exports, export opportunities provided by privileged market access and potential future ethanol certification schemes, and the argument that externalities justify mandated domestic consumption.

Energy Arbitrage: Gasoline versus Ethanol

The first consideration is that of domestic ethanol versus gasoline consumption. At low fuel blends, ethanol and gasoline are near-perfect substitutes: distribution infrastructure and vehicles are largely unaffected by fuel switching and blending ethanol requires a relatively minor investment in equipment.[89] Yet due to imperfections in the market and mandated ethanol demand in some nations, ethanol and gasoline prices are not strongly correlated. A cursory analysis of fuel ethanol and reformulated blendstock for oxygenate blending (RBOB) gasoline spot prices on the U.S. Gulf Coast, the closest major fuels market with a sizeable demand, over six months of 2008 indicated a correlation of 0.81. Over this same period ethanol sold at an average price premium of 0.79 USD per energy

[87] Conversely, by this same law, if ethanol costs more to produce at home than overseas, the Dominican Republic should not be in the ethanol business.
[88] In oil and gas markets these are referred to as *netback costs*. Indeed by the same logic oil producers generally supply the closest markets first. (EIA oil market description.)
[89] "Biofuels for Transport." Worldwatch Institute. Earthscan, London. 2007. Page 319.

equivalent gallon to gasoline.[90] This ethanol price premium is a persistent feature of the ethanol/gasoline price relationship.

Thus an opportunity presents itself for Dominican ethanol to be used internationally in a form of energy arbitrage. If there is an energy equivalent price premium on ethanol, the Dominican Republic should forgo domestic consumption and export. If the energy equivalent price of ethanol is lower than that of gasoline, the Dominican Republic should consume ethanol at home. The main constraining factor in such a scenario would be the number of flex fuel vehicles in the Dominican fleet. If international gasoline and domestic ethanol prices are at energy parity and there are no other market distortions, the Dominican Republic should consume ethanol before exporting so no value is lost to transportation costs.

Notably, from the perspective of the current account, the Dominican Republic should not consume ethanol at home to displace gasoline if it is cheaper only due to tax treatment. The end result of such a consumption pattern would not only erode the tax base, but also have a net negative effect on the current account. If tax incentives mask the real cost disadvantage of ethanol, the Dominican Republic is actually consuming the more expensive fuel. This ethanol could be exported and cheaper gasoline imported, with the difference benefiting the current account. Figure 7 below summarizes optimal trade strategies under different market conditions. The box on the lower right reflects current market conditions. Notably, the current consumption mandate only makes sense if ethanol is cheaper than gasoline (see the upper right box in the chart below).

Figure 7: Ethanol Trade Strategies

	Ethanol world price < DR ethanol price of production	**Ethanol world price > DR ethanol price of production**
gasoline import price > ethanol world price	Import ethanol	consume ethanol at home first, export surplus supply
gasoline import price < ethanol world price	Import gasoline, don't make ethanol.	Export ethanol, import gasoline

Note: all prices are in energy equivalent gallons

[90] Correlation from June through December. A gallon of ethanol has roughly 67% the energy content of a gallon of gasoline. USGC RBOB gasoline prices taken from EIA petroleum product price data tables. USGC ethanol spot prices taken from Bloomberg.

Naturally, there are some costs associated with switching between domestic ethanol consumption versus exports; however, these are relatively minor. The switching costs break down into two categories: stranded costs associated with domestic consumption which arise when switching to export, and stranded costs associated with export which arise when switching to domestic consumption.

In the Dominican Republic an investment of roughly 400,000 USD is needed for blending facilities to supply E5 nationally. The largest expense is for storage capacity, evaluated at roughly 320,000 USD.[91] By extension about 800,000 USD would be needed to supply a nationwide E10 blend. This total investment is not significant. It is less than 0.2% of the investment needed in refineries, and less than 2% of the value of the ethanol needed annually to supply an E10 mandate (at SEIC prices). As mentioned earlier, at low blends, virtually no additional investment is required to distribute ethanol through existing filling station equipment; the use of high blends is limited by flex fuel vehicle fleet size.

Ethanol exports could be realized quite simply by loading ethanol on to tankers from the storage capacity at the above REFIMDOSA blending facilities. Assuming that chemical tankers could load ethanol with the same frequency as trucks distributing gasohol across the Dominican Republic, no additional investment in storage capacity would be needed. Investments needed in loading facilities are also relatively minor. As a reference, the recently completed Public Ethanol Terminal in Paranagua, Brazil cost only 9 million USD, and has storage capacity 16 times larger than the facilities proposed for REFIMDOSA.[92] Thus stranded infrastructure costs arising from switching between ethanol export and domestic consumption are not likely to be a major impediment to following the trade strategy outlined in this paper.

A final potential barrier to entering and leaving the export market is long-term delivery contracts. There is little publically available information on the type of contracts used by ethanol exporters, however a cursory look at ethanol import trade patterns in the United States suggest that long-term contracts are not the norm, and if they are, they are frequently not observed. Over the past two years monthly volumes of ethanol imported

[91] "Proyecto de Mezcla Etanol Carburante/Gasolina (E5-E25). SEIC. 2006. Pages 21-25.
[92] "Ethanol Terminal of Paranaguá." Gazetal Mercantil – Online News. July 25th 2008.

from Costa Rica, El Salvador, Jamaica, and Brazil were very volatile, often changing by over 100% month to month.[93] Moreover, assuming continued growth in volumes of international ethanol traded, any remaining contract inflexibility is likely to be a temporary problem. As seen in the case of oil, as commodity trade volumes grow inflexible long-term contracts are often displaced by deeper spot and futures markets.

Market Access

The second major consideration in determining trade strategy is market access. The Dominican Republic has tariff-free access to both the United States and European Union ethanol markets through DR-CAFTA and the Contonou Agreement, respectively. Ethanol prices within these markets are substantially higher than the world price. This price gap will likely continue as long as protective tariffs on ethanol imports remain (particularly on Brazilian ethanol). From June to December 2008, the USGC FOB spot ethanol price was 0.25 cents higher than the Brazilian Sao Paulo FOB; European ethanol spot prices in Rotterdam (duty paid) were at a premium of 0.72 USD to Brazilian ethanol. This price gap suggests it would be advantageous for the Dominican Republic to import Brazilian ethanol at world prices for domestic consumption, and export Dominican ethanol to capture the rents generated by the European and U.S. import tariffs. Notably, the only reason the Dominican Republic would want to pursue this strategy is if there were substantial benefits from domestic ethanol consumption, or if Brazilian ethanol were cheaper than gasoline.

Certification Opportunities in Trade

Similar opportunities may exist for various ethanol sustainability certifications. In recent years a number of governments have established or are in the process of designing biofuels standards for net GHG emissions, land use, labor practices, and other characteristics of biofuels deemed necessary for "sustainability." These standards are enforced through restricted access to policy incentives supporting biofuels consumption. This is a topic in flux; negotiations are ongoing on the design of international biofuels

[93] EIA Petroleum Navigator. "U.S. Imports by Country of Origin, Oxygenates – Fuel Ethanol." Monthly data from 2004-2008. Accessed February 25, 2009.

standards, any many questions remain on how to effectively measure, manage, and monitor complex biofuels supply chains.[94]

It is likely that ethanol certified under any such scheme would cost more than ethanol that did not meet the certification standards. For example, according to Smeets et al. 2006, the cost of producing ethanol in Brazil under the sustainability standards established by the Dutch Parliament would increase by 56% using manual labor, and 24% using "green mechanization."[95] If such a certification scheme were to gain currency the higher costs of producing "sustainable" ethanol may result in a market price premium. Again the Dominican Republic could benefit from energy arbitrage by producing and exporting certified ethanol while importing cheaper, uncertified ethanol for domestic consumption. While this may be ethically questionable, such a trade strategy would effectively get Western consumers to subsidize the sustainability (e.g. good labor conditions and environmental practices which would otherwise not be cost-competitive) of domestic ethanol production. Again, any domestic ethanol consumption only makes sense if it is cost-competitive with gasoline on world markets.

Gasoline Consumption Externalities

Thus far we have seen that it makes little sense to consume ethanol domestically when it is cheaper to consume imported gasoline. But perhaps negative consumption externalities for gasoline (or related oil imports) might justify paying higher prices to consume ethanol at home? In the U.S. policy dialogue on reducing gasoline consumption, three types of externalities have been identified which could support biofuels consumption: greenhouse gases, local pollution, and foreign oil dependence.[96]

The reduction of greenhouse gases in principle could be considered an externality associated with consumption of Dominican ethanol.[97] However Dominican ethanol,

[94] "Biofuels and sustainability: Is certification the answer?" New and Analysis. Volume 2, No. 4. International Centre for Trade and Sustainable Development. May 2008. Accessed online at http://ictsd.net/i/news/bioresreview/12094

[95] Smeets E., Junginger M., and Faaj A. "Sustainability of Brazilian bio-ethanol." Copernicus Institute, Utrecht University. 2006. Page 78.

[96] National Academies Press. "Effectiveness and Impact of Corporate Fuel Economy (CAFÉ) Standards). 2002. Pages 85-86. Parry I, Walls M, Harrington W. "Automobile Externalities and Policies." Resources for the Future Discussion Paper. January 2007.

[97] For a small, tropical, island nation like the Dominican Republic it could be argued that this externality is even higher due to higher than normal vulnerability to rising sea levels, power storm, desertification, etc.

regardless of where it is consumed, will have the effect of reducing global GHG emissions.

As a clean-burning oxygenate, domestic ethanol consumption would reduce the local environmental externalities related to gasoline consumption. Ian Parry et al. estimated the local pollution consumption externality at $0.42 per gallon of unleaded gasoline for the United States. [98] However, no such estimates exist for the Dominican Republic, and it is unclear how large or small the externality may be due to the numerous factors involved in these calculations. Studies of local air pollution externalities are highly dependent on location. Traffic patterns, vehicle fleet, weather patterns, and even cost of health care can impact estimates, which are largely driven by associated morbidity. Economic loses from morbidity, in turn are driven by lost earnings, which suggests that this externality is likely to be substantially lower in the Dominican Republic than in the United States.

Dependence on foreign oil for fuel hurts the Dominican Republic through 1) the loss of economic efficiency due to oil price volatility,[99,100] and 2) the negative impact of sustained high oil prices on GDP (if oil prices are high).[101] Theoretically these externalities, often referred to within the rubric of "energy security," could be reduced if the Dominican Republic were to isolate itself from global fuel markets by displacing oil imports with domestic ethanol, thus reducing economic vulnerability to the price of oil. However, a number of practical problems suggest that these energy security benefits are unattainable: 1) Such an isolationist trade policy could result in substantial rents for ethanol producers and the state, to the detriment of consumers. 2) Ethanol and gasoline prices are increasingly linked.[102] If oil prices spiked severe price controls on ethanol would be needed to avoid price transmission; this could easily lead to a black market. 3)

[98] Parry I, Walls M, Harrington W. "Automobile Externalities and Policies." Resources for the Future Discussion Paper. January 2007. Page 36.
[99] Rapid changes in oil prices lead to the reallocation of resources (eg. technologies, labor, etc.) across the economy to maximize efficiency. The process of reallocation itself consumes resources which could be used for other purposes if the oil price were static.
[100] David Greene and Paul Leiby estimate the size of the oil volatility externality for the United States at 50 to 170 billion USD in 2005 in their article "Oil Independence: Goal or Empty Slogan."
[101] David Greene and Paul Leiby. "Oil Independence: Goal or Empty Slogan." Oak Ridge National Laboratory. March 2007.
[102] "Analisis Economico de Precios del Bioetanol para mezclas gasolinas." United Nations, ECLAC. Table 1, page 6.

Even if absolute price control could be achieved, suppressing Dominican ethanol prices would alienate the investors needed to fund the new industry.

Thus we see that environmental and energy security externalities either do not apply to the Dominican situation, or are simply too poorly understood to justify a potentially costly mandate without further research. On a final note, as seen in section two, gasoline in the Dominican Republic is taxed at over 30%, or roughly 1.60 USD. It is unlikely that combined, all economic, social, and environmental externalities that could be addressed through ethanol consumption would exceed this value.[103] Thus, further reductions of gasoline consumption imposed through an ethanol mandate would be economically inefficient.

Summary: Non-interference for Maximum Benefit

Indeed, it appears that a laissez-faire approach to the ethanol trade is less risky for the Dominican Republic than a rigorous ethanol mandate. The balance of ethanol exports and domestic consumption, when left to the market, will maximize economic welfare. This contradicts conventional practice in ethanol development. To date no nation has successfully developed a biofuels market without a state mandate or subsidies.[104] For developing countries subsidies are generally an expensive luxury. There is also a risk that if a mandate limits opportunities for trade, it could be economically damaging. Depending on world prices, an ethanol mandate can limit both imports (of gasoline and ethanol) and exports (of ethanol). Other measures typically used to foster industry development such as tax breaks, demonstration projects, government credit, appropriate regulatory frameworks, and targeted improvement in the business environment could prove to be more cost-effective policy tools for developing nations seeking to create biofuels industries.

In the current price environment, a mandate would constrain gasoline imports to the Dominican Republic and ethanol exports to the United States and Europe, generating net losses in the current account. If the mandate were to be set at 10% by volume,

[103] As a reference Ian Parry estimated all externalities associated with gasoline consumption at $0.60 per gallon (including local pollution, greenhouse gases, and oil dependency) for the United States.
[104] Henry Lee, William C. Clark, and Charan Devereaux. "Biofuels and Sustainable Development: An Executive Session on Grand Challenges of the Sustainability Transition. Summary Report." San Servolo Island, Venice. May 19-20 2008. Page 7.

roughly 29m gallons of ethanol would have to be consumed by the local market. The average spot price for USGC ethanol from June to December 2008 was 2.25 USD per gallon, or 3.36 USD adjusted for energy content, and for USGC RBOB gasoline was 2.38 USD per gallon. Assuming a 0.10 USD transportation cost between the Dominican Republic and the U.S. Gulf Coast, we can calculate the losses from a 10% ethanol blend mandate as the quantity of ethanol not exported times the price difference between a gallon of gasoline and its equivalent in ethanol minus the cost of transportation. Thus we see that a 10% ethanol blend mandate results in an annual loss of ((3.36 – 2.38 – 0.10) * 29m =) 26 million USD.

In summary, at present it makes sense for the Dominican Republic to produce ethanol to supply foreign mandates, and only use to it supply the domestic market if it is cheaper on the export market than imported gasoline. Even if oil prices rise dramatically, exporting ethanol to restricted markets is still likely to yield greater benefit, but instead of importing gasoline the Dominican Republic would import ethanol at lower world prices. For the foreseeable future it appears that the Dominican economy will benefit more from privileged access to markets, where ethanol prices are likely to remain above world prices, then by displacing oil imports. The benefits of this strategy are not unique to the Dominican Republic. Given the price premium on ethanol (and other biofuels relative to petroleum based fuels) in most markets, consumption mandates appear to be a misguided policy for ethanol development in developing nations.

4. Conclusion

Like many of its neighbors in Central America and the Caribbean Basin, the Dominican Republic appears poised to pursue ethanol as means to attain economic and development goals**.** The Dominican Republic is well positioned to become a low-cost producer of ethanol for both domestic consumption and export. The island nation has adequate land resources, can produce ethanol at competitive prices, and enjoys privileged access to the world's leading ethanol markets. However, production is unlikely to move forward as long as global ethanol prices remain depressed.

As seen in the case of the Dominican Republic, an open approach to ethanol trade is preferable to mandated domestic consumption for developing nations. Various opportunities exist to leverage ethanol market access, future certification schemes, and most importantly, the price premium on ethanol relative to gasoline. Consumption mandates are in effect barriers to trade with potential to generate substantial economic losses for the host country, while providing limited benefits. As long as the EU and United States continue to mandate ethanol consumption, developing nations seeking to develop biofuels industries should take advantage of these programs and forgo costly mandate programs at home.

Appendix I: SEIC Assumption on the Cost of Sugar Cane

The SEIC analysis uses a calculated value for the costs of cultivation for on hectare of sugar cane in the Dominican Republic to arrive at costs estimates for various yield levels in the Dominican Republic. This is done in the following fashion. The cost of cultivation for one ton of sugarcane is reported as 9.74 USD, and the average yield is reported as 71.17 tons per hectare. This results in a total cost per hectare of (9.74*71.17 =) 693.00 USD. The SEIC analysis then assumes that costs per hectare are independent of yield, and through division arrives at a range of cultivation costs at various yield levels:

Agricultural Productivity (tons/ha)	**31.8**	**39**	**46**	**53**	**60**
Cost of cane (USD/ton)	21.8	17.85	15.11	13.09	11.56
Calculation	693/31.8	693/39	693/46	693/53	693/60

The final price for sugarcane to the mill in the Dominican Republic is estimated at 14.41 USD per ton. The SEIC appears to have arrived at this figure by simply adding the margins reported for Brazilian cane growers (2.85 per ton) to the cost of cane at 60 tons per hectare (11.56 + 2.85 = 14.41).[105] Clearly this isn't the soundest method of estimating cane cultivation costs, especially as a large part of the decline in unit costs for ethanol production is attributed to higher cane yields. The cost of cane cultivation cannot be seen as fixed – higher levels of fertilizer and irrigation are associated with higher yields. However, without detailed study of the sector, the values generated are reasonable benchmarks for attainable sugar cane cultivation costs in the Dominican Republic.

[105] "Proyecto de Mezcla Etanol Carburante/Gasolina (E5-E25). SEIC. 2006. Page 15.

Appendix II: Price Data

Price data was taken from Bloomberg, the EIA, and SEIC. The chart below summarizes all historical price data used in this paper.

Commodity	Average value (June 2008 – December 2008)	Source	Notes
Gasoline in the Dominican Republic	2.68 USD / gallon	State Secretary of Industry and Commerce weekly gasoline price bulletins[106]	Import parity price for regular gasoline
RBOB USGC spot price	2.38 USD / gallon	Energy Information Administration[107]	
Brazilian anhydrous ethanol spot price in Sao Paulo	2.00 USD / gallon	Bloomberg. IASEBRLC. ICIS ethanol price, fob Sao Paolo[108]	Domestic ethanol price used; spot price includes 3.6% excise tax
USGC Spot Ethanol	2.25 USD / gallon	Bloomberg. ETHN US GULF COAST SPOT[109]	
Rotterdam Spot Ethanol	2.72 USD / gallon	Bloomberg. Kingsman T2 spot anydrous ethanol. KIBFETHA[110]	Import duty paid.

[106] Average of weekly PPI reported in from June through December 2008. "Aviso precios combustibles." SEIC. Accessible at www.seic.gov.do.
[107] EIA petroleum product price data tables. Average value from June through December 2008. Accessible at eia.doe.gov.
[108] Bloomberg. IASEBRLC. ICIS ethanol price, fob Sao Paolo. Average value from June through December 2008.
[109] Bloomberg. ETHN US GULF COAST SPOT. Average value from June through December 2008.
[110] Bloomberg. KIBFETHA. Kingsman T2 spot anhydrous ethanol. KIBFETHA. Average value from June through December 2008.