Ethanol in Brazil

By Emily Winfield

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I. Introduction

Brazil is in its greatest period of sustainable growth since the 1970's. The export of manufactured goods and services is giving the economy balance, allowing the country to pay down debts, lower interest rates, and curb spending. Additionally, Brazil is the leading exporter of chicken, coffee, sugar, soy, beef, and orange juice. Recent increases in the price of these commodities continue to fuel Brazilian economic growth.

One of the most exciting export commodities in Brazil is ethanol. Ethanol is ethyl alcohol, produced for use as an additive to gasoline, by itself as an alternative to fuel, or more commonly, in flexible-fuel vehicles that employ a blend of ethanol and gasoline. In Brazil, the production of ethanol involves the fermentation of sugar obtained from sugarcane. The abundance of sugarcane in the country provides Brazil with a distinct competitive advantage in the ethanol industry.

Brazil produces two types of ethanol—anhydrous and hydrous. Anhydrous ethanol mixes with gasoline, and hydrous ethanol is a complete substitute for gasoline. There are approximately 303 ethanol distilleries in Brazil; 100 are located in the North-Northeast of the country and 203 are located in the Center-South, an area revered as the lowest-cost sugarcane-producing region in the world.

Brazil consistently exports more ethanol than any other country in the world. Ethanol has many advantages that make it a desirable fuel alternative. It blends well with gasoline, it is environment friendly, and it provides critical fuel flexibility in an era of unprecedented crude oil prices. Although many countries are involved in the large-scale production of ethanol, the production of ethanol from sugarcane in Brazil is the only large-scale production that is cost competitive with a petroleum fuel for transport. This Briefing Paper provides a historical perspective on the development of the ethanol industry in Brazil, highlighting the importance of government support and identifying key factors for the future success of the industry.

II. History of Brazil's Ethanol Industry

A review of the historical development of Brazil's ethanol industry provides important context. Brazil was the first country to engage in cost effective, large-scale bioethanol production. Accordingly, it was the first to encounter, as well as address, a number of significant challenges. These innovative solutions resulted in both a thriving Brazilian ethanol industry and a template for other countries interested in ethanol production. The following historical context highlights the role of the Brazilian government in fostering growth of the industry, as well as its current role in ensuring maintenance and survival in the face of increased competition.

a. The First Ten Years

The oil crisis of 1973-74 quadrupled the price of crude oil and effectively triggered the growth of Brazil's industry. At this time, Brazil was importing four-fifths of its oil. On November 14, 1975, the government established Proalcool to encourage the use of ethanol as a fuel substitute for gasoline, and to increase domestic ethanol production for industrial use. Guidelines for Proalcool were established by the Institute do Acucar e do Alcool (IAA, Institute of Sugar and Alcohol), a government agency that was part of the Ministry of Industrial Development and Commerce.

The first ten years of Proalcool resulted in an annual 35% increase in ethanol production. Sales of vehicles fueled solely by hydrous ethanol comprised more than 90% of countrywide auto sales and the amount of sugarcane harvested between 1975 and the mid 1980's doubled. By 1979, there were 104 ethanol distilleries in operation. This rapid expansion was due in part to generous incentives in the form of credits provided for distillery construction. In many cases, these credits amounted to a government subsidy for as much as 75% of the total cost of the project. Additionally, there was a corresponding expansion in the area of land used for cane cultivation. Between 1978 and 1979, cane cultivation in San Paulo, the country's largest and lowest-cost ethanol producer, increased by 31%

b. Continued Growth

A second oil crisis in 1979 resulted in government expansion of Proalcool to promote the use of ethanol as automobile fuel. Again, the government employed subsidies to foster growth

of the industry, providing tax incentives for the purchase of cars fueled by hydrous ethanol. It required that all vehicles in the official government fleet be ethanol-fueled. Additionally, the government subsidized ethanol prices, ensuring that the retail price of hydrous ethanol was at most 65% of the retail price of gasoline. Despite serious financial problems in the early 1980's the government refused to reduce the price difference between gasoline and hydrous ethanol from 35% to 25% until 1989.

c. Minor Setbacks

However, this seemingly infinite expansion soon encountered significant setbacks. In 1986, a drop in the price of international oil price resulted in an increase in oil imports and a decrease in demand for ethanol. Although the government intended the Proalcool incentives to be temporary, quickly falling oil prices required continuation of the subsidies. Rather than alleviate the serious financial drain on government funds by ending subsidies, the government elected to continue its financial support of the industry, reasoning that whereas a withdrawal of the subsidies would relieve the treasury it would have a significant negative impact on the industry. In addition to subsidies and price guarantees, the government provided many public loans and state guaranteed private bank loans to growers and producers during the 1970's and 1980's to provide for construction and start up costs associated with new ethanol distilleries. By 1986, the government was so concerned that these loans would not be repaid that it formed an interdepartmental commission to investigate the status of repayment and to propose refinancing measures. In 1989, experts estimated the debt arising from these loans at U.S. $1.5 billion (1999 U.S. dollars); by February 1991, the debt stood at U.S. $2.8 billion (1999 U.S. dollars). In addition to financial problems, concerns emerged regarding other negative consequences. These problems included: an exacerbation of historical labor problems, water contamination from vinasse (a byproduct of ethanol production), air pollution from the burning of cane residues left in the fields, and competition for land between cane for ethanol and other food and agricultural products.

In 1988, the world sugar price increased. As a result, many sugarcane growers diverted their crops to the export market rather than ethanol production. This resulted in a severe shortage of ethanol and greatly discredited the governance of Proalcool. The state could no

longer sustain subsidies to the ethanol industry, and both production and consumption of ethanol became nearly nonexistent. For the first time, the government authorized ethanol imports to accommodate the decrease in domestic supplies. Soon, Brazil became the world's largest importer of ethanol, importing an average of 0.6 billion liters of ethanol annually between 1989 and 1996.

d. The Industry Recovers

This period of inactivity continued until 1999, when an increase in oil prices resulted in a renewed demand for anhydrous ethanol that refreshed governmental interest in the ethanol industry. Prior to 1999, the vast majority of ethanol produced and consumed was hydrous ethanol, which acts as a complete substitute for gasoline. When the price of oil dropped through the 1980's and 1990's, so, too, did the production of vehicles fueled solely by ethanol as well as consumer interest in the purchase of these vehicles. Although Brazil remains the only country that uses ethanol as a complete substitute for gasoline, the country switched its focus from the production of ethanol to anhydrous ethanol. Anhydrous ethanol readily mixes with gasoline for use as a blended engine fuel. In 2003, Brazil launched Flex Fuel Vehicles, its new generation of ethanol- powered vehicles. Flex fuel vehicles can run on gasoline, ethanol, or a combination of both. They have a sensor that checks the alcohol content in the gasoline blend and automatically adjusts engine operation. Volkswagen introduced the first flexible fuel vehicles in 2003 and by 2004 flexible fuel vehicles accounted for more than 17% of the Brazilian auto market. In 2005, sales of the vehicles continued to increase, accounting for 54% of the country's new auto sales.

As an additional measure to bolster production, the government proposed a tax on sugar exports in mid 2002 to take effect whenever ethanol stocks appear insufficient to meet demand. The purpose of this tax was to prevent the diversion of sugarcane to the sugar export market. To avoid this tax, ethanol producers agreed to produce an additional 1.5 billion liters of ethanol in 2003-2004, and agreed not to exceed a maximum selling price to alcohol distributors.

III. The Future of the Industry

Production continues to increase, and forecasts project consistent growth in the industry. Given the extreme increase in the price of crude oil, alternative fuels, such as ethanol, are a

desirable solution to a problematic worldwide dependence on petroleum-based fuels. To realize its goal of dominating the ethanol export market, Brazil must effectively manage three key factors: its role in the international sugar market, ethanol exports, and domestic research and development.

a. The Role of the Sugar Market

Sugar represents a very important part of Brazil's economy. Brazil produced 423 million tons of sugarcane in 2006, which amounts to 31% of global production. The country is the world's largest producer of both raw and refined sugar, accounting for 20% of global sugar production. Since sugarcane is the feedstock of choice for ethanol production in Brazil, developments in the sugar industry are closely linked to policy initiatives in the ethanol markets. For example, many of the state's ethanol plants are actually compound sugar mill/distillery complexes, capable of producing both refined sugar and ethanol. Production can shift from 60% ethanol and 40% sugar to 60% sugar and 40% ethanol. This split mill innovation allows Brazil to capitalize on the volatile price structure of the international sugar market by producing more sugar when rates are high, and more ethanol when rates are comparatively lower. In this way, Brazil maximizes its return on sugarcane.

Maintaining the balance between sugar and ethanol is vital to the survival of both industries. The sugar/ethanol industry contributes 2% to the national GDP. The value of production reached eight billion dollars in 2006, accounting for 17% of the country's agricultural output. The sugar/ethanol industry alone employs one million people (50% in farming, 50% processing), which constitutes 2% of the Brazilian workforce. Additionally, the industry accounts for 21% of exports. Whereas large-scale ethanol production is a relatively new industry for Brazil, the country's sugar industry originated in the sixteenth century. Favoring ethanol at the expense of the well- established sugar industry could have devastating effects. Conversely, severely limiting the use of sugarcane for the production of ethanol ignores the very real potential in the ethanol industry. Accordingly, maintaining a successful balance between the two is of critical importance.

b. The Ethanol Export Market

Brazil's interest in ethanol originated as an interest in energy independence. The early financial success of the country's ethanol industry depended solely on domestic ethanol consumption. As discussed previously, the government consistently passed legislation that created a demand for ethanol by mandating its use, as well as discouraged the diversion of sugarcane into more profitable foreign export markets. Today, however, ethanol accounts for only 40% of Brazil's transportation fuel demand, with the rest provided by petroleum-based fuels. The primary domestic use of ethanol in Brazil is in the use of flex fuel vehicles, vehicles designed to run on a combination of gasoline and ethanol. The flex fuel vehicle market grew from 1% of new auto sales in 2001 to 70% of new auto sales in 2005 and continues to generate a steady domestic demand for ethanol.

Today, Brazil exports a significant portion of its ethanol. As oil prices continue to rise and countries struggle to meet their own domestic demands, the export of ethanol is quickly becoming the key strategic variable in the growth of the industry. In 2006, the country exported approximately 19% of the total 16 billion; this amount constitutes 70% of the world's supply. A partnership between the Ministry of Science and Technology and the University of Campinas in Sao Paolo is conducting a study to devise a plan for Brazil to export ethanol as a substitute for 10% of the global use of gasoline in the next twenty years. If this plan is a success, Brazil will export 200 billion liters per year by the year 2025, an increase in export of nearly 67%. To accommodate the increased production, the amount of land planted with sugarcane will increase from 6 million hectares to 30 million hectares.

The success of Brazil's booming export enterprise is attributed to a number of variables. Unlike Brazil, countries such as the United States and Japan are only beginning to replace significant proportions of gasoline consumption with ethanol alternatives. This creates a real possibility that demand for ethanol will quickly surpass domestic production in these countries. Since most countries will not have the agricultural or manufacturing infrastructure to support the increased demand, they will seek out sources of import. For example, in his January 2007 State of the Union Address, U.S. President George Bush announced his goal for a 20% reduction in the U.S. use of gasoline by 2017. To meet this goal, the U.S. will need an additional 135 billion liters of ethanol annually. Currently, the U.S. is the largest importer of ethanol from Brazil, importing 58% (1.74 billion liters) of Brazil's annual ethanol production. Given the cost and

space limitations of American ethanol production, it is likely that the U.S. will import a large portion of this increased need from Brazil. Efforts by other countries to reduce their dependence on petroleum-based fuels will likely create comparable demands on the importation of ethanol.

Furthermore, even if countries currently importing ethanol find a way to match their production abilities to their domestic needs, the high cost of production makes it unlikely for them to cease importing ethanol from Brazil. Brazil is the only large-scale cost efficient producer of ethanol. The United States produces ethanol from corn, a considerably more expensive feedstock. Currently, U.S. producers can compete because the United States government places a $0.51 per gallon tariff on ethanol imported from Brazil. However, if domestic demand were to exceed a level that U.S. producers could meet, it is possible that the U.S. government would need to reconsider the high tariff on imported ethanol. In this way, Brazil could easily become the world's low cost provider of ethanol.

Inherent in this relationship, however, is the potentially devastating residual effects of a global economic downturn. Analysts warn that an economic recession could dampen demand for ethanol, and, in turn, significantly reduce the amount of ethanol that Brazil exports. In this case, Brazil might find itself with an excess supply of ethanol. The degree of impact of a reduced demand could be minimized, however, if demand for sugarcane remains steady. As detailed above, the majority of ethanol plants can produce more sugar or more ethanol at will. If demand for sugarcane remained steady, Brazil could elect to divert more sugarcane into the sugar refineries, and less to ethanol mills, and effectively minimize losses. However, a long-term global economic recession would most likely result in a reduced demand for all commodities, which would have a much more sever impact on Brazil's ethanol industry.

In anticipation of increased foreign demand, Brazil recently enacted legislation lowering the required percentage of ethanol in gasoline blends from 25% to 20%. The purpose of this legislation was to ensure that the country could continue to meet its own domestic demands from the increased sale of flex fuel vehicles, while remaining responsive to export opportunities.

c. Research and Development

One of the most important factors underlying the present as well as future success of Brazil's ethanol industry is its investment in research and development. Agricultural technology innovations such as new variety development, biological pest control, improved cultivation management and greater soil selectivity have resulted in a three-fold increase in the yield of ethanol produced as compared to the yield in 1975. Cane growers in Brazil use more than 500 commercial cane varieties that are resistant to most of the crop diseases found in the country. The amount of harvesting area in the Center-South Region (the area of the country most conducive to sugarcane production) increased from 2.8 million hectares in 1993 to 4.2 million hectares in 2003. Technology permitted similar gains with respect to production efficiency. In 1975, Brazil produced approximately 2,000 liters of ethanol per hectare of sugarcane. By 1999, the yield increased to 5,000 liters of ethanol per hectare and to 5,900 liters per hectare by 2004.

In addition to increased yields, technological innovation promises to alleviate many of the environmental concerns that emerged during the late 1970's and early 1980's. As a result of focused research, the vast majority of mill/distillery complexes are nearly self sufficient in their energy consumption. This self-sufficiency is due to research that generated a method for converting bagasse, a residue obtained after crushing the cane prior to fermentation, into energy to fuel the production facility. Current research focuses on methods of converting the sugarcane residues left behind after harvest into ethanol. Generally, growers burn these residues when the harvest is complete, resulting in the production of an additional 4500 kilograms of carbon dioxide each year. Low cost conversion of sugarcane trash would greatly increase the cost-competitiveness of sugarcane- derived ethanol, while alleviating air pollution concerns.

IV. Criticisms of the ethanol industry

Not everyone is pleased with the growth of Brazil's ethanol industry. Whereas the growth of the ethanol industry is likely to boost the Brazilian GDP, concerns remain that the majority of citizens will not benefit from the project. The Forum of Resistance to Agribusiness, a consortium of non-governmental organizations (NGOs) throughout South America recently released a statement insisting that the implementation of a program for the production and export of biofuels presents a grave threat to the natural resources of Brazil as well as the sovereignty of Brazilian citizens. "The era of biofuels will reproduce and legitimize the logic of the occupation

of rural areas by multinational agribusiness and perpetuate the colonial project to subvert ecosystems and people to the service of the production and maintenance of a lifestyle in other societies." The relationship that is of greatest concern to the Forum is the growing partnership between Brazil and the United States. Given U.S. plans to import greater quantities of ethanol from Brazil, the Forum fears Brazil will compromise the livelihood of many Brazilians, particularly the rural poor, to meet U.S. demands.

This fear originates from the history and social dynamics in rural areas resulting from the sugarcane industry. Sugarcane is one of the oldest industries in Brazil, dating back to the colonial era. Since sugarcane is the feedstock of choice for the production of ethanol in Brazil, the Forum fears that the growth of the ethanol industry will result in a similar pattern of labor exploitation and land concentration.

a. Vertical integration and labor concerns

The corporate governance of the industry shows signs of concentration and vertical integration. Foreign investors are taking notice of the potential of the industry and interested parties include biofuel industry leaders such as Archer Daniels Midland (ADM) and Cargill, hedge fund investors, and banking giant Goldman Sachs. Current foreign capital involvement amounts for only 4.5% of the industry. However, this number is likely to increase rapidly as Brazil's low production costs attract foreign groups interested in investing in the ethanol industry.

In the past, control of the ethanol industry remained with small businesses that controlled both the cultivation of the sugarcane and production of the ethanol. Currently, the ten top producers control only 30% of the industry. However, the trend in the ethanol industry is quickly mirroring the soybean industry, with an increase in mergers and acquisitions resulting in a rapid concentration of the industry. Today, a few multinational conglomerates control all soybean production in Brazil. Many of these same companies are investing in the ethanol industry, including Louis Dreyfus Commodities and Tereos, both based in France, as well as U.S.-based Cargill.

The Forum fears that concentration in the industry will increase land devoted to the cultivation of sugarcane, resulting in a monoculture of sugarcane and an increase in rural poverty. A monoculture economy impedes the creation of other forms of work, leaving rural workers at the mercy of a single industry.

b. Environmental concerns

In addition to labor concerns, there are serious environmental considerations surrounding the growth of the ethanol industry. Supporters of the industry, including industry leaders, government and mainstream media, argue that an increase in ethanol exports will boost economic growth and sustainable rural growth for Brazil, while reducing global warming and dependence on fossil fuels. Critics counter that the monoculture of sugarcane will result in massive environmental destruction. According to FoodFirst, an NGO based in Oakland, CA, Brazil will need to clear an additional 148 million hectares of forest to accommodate the increased export demand. Since sugarcane generates a high price per hectare, other agricultural products take second priority. Accordingly, sugarcane dominates the regions with better climatic conditions occupying lands once used for growing grain to feed grazing livestock.

c. Signs of resistance

Resistance to the rapid shift in land use is already evident. As the expanding ethanol industry threatens a loss of rural livelihood, the frequency and intensity of agrarian conflicts continues to rise. Between 2000 and 2004, the highest number of agrarian conflicts for any one year was nine; in 2005, there were nearly 60 such conflicts. Brazil has one of the largest rates of land and income inequality in the world as well as an incredibly organized agrarian reform movement. This results in a constant socioeconomic tension between wealthy land owners and poor rural agrarians. An aggravation of this tension by growth in the ethanol industry is likely to result in an increase in violent conflicts.

Social groups, NGOs and other interested organizations do not necessarily advocate the abandonment of the ethanol industry. Rather, these groups assert that the government must reconsider its priorities, incorporating concepts of food sovereignty into its development plan and prioritize the use of land for the production of food for Brazilians. The concept of food

sovereignty includes access to nutritious foods in adequate quantities, as well as the right of the people to define their own agrarian policies, producing food for consumption before producing it for the export market. Critics argue that current trends in growth and market concentration are in direct opposition to notions of food sovereignty and agrarian reform.

IV. Conclusion

The exponential increase in worldwide gasoline prices continues to drive interest in the potential of ethanol as an alternative fuel source. Brazil has both the agricultural resources and processing infrastructure to capitalize on this demand. However, sustainable development should maximize opportunities for all members of society, not just those with wealth or power. Accordingly, the challenge to the future of Brazil's ethanol industry is to seek a balance between the financial and technological demands of industry domination with the need for socially conscious policies on industry development.

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