

BRAZILIAN GOVERNMENT POLICIES IN THE ETHANOL PROGRAM:
A MODEL FOR THE REST OF THE WORLD?

By

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By

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To my parents. Their love and support throughout my life has allowed me to reach this level in my academic career. Their efforts to make sure I get a good education have inspired me to do this and much more.

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Today many countries, in Latin America, as well as the United States, are affected by rising energy costs. Many of these countries produce sugarcane, corn, soybeans, and other crops that could be converted into alternatives fuel sources such as ethanol and biodiesel. The question addressed by this work is whether Brazil's experience over the last thirty years can serve as a model for the rest of Latin America and the world. This thesis suggests that the Brazilian government's successful policy management during the last three decades can indeed serve as an example for the rest of the world. This work first examines the history of the Brazilian ethanol program and the different policy options that were implemented by the Brazilian government. After analyzing both the historical context and the policies that have worked for Brazil, this work highlights the lessons that other countries can obtain.

This thesis also studies the current energy situation in two other countries: Argentina and the United States. The current policy environment and the biofuel situation in each country is discussed in order to understand the steps taken by other countries in the region to alleviate the economic impacts associated with the high costs of fuel. Important differences arise when Brazil's energy policy history is examined side-by-side with experiences in the United States and

Argentina. At the end, lessons from the Brazilian experience are derived in this work that suggests policy measures that countries can implement when looking to establish a successful alternative fuel program.

CHAPTER 1 INTRODUCTION

During an era in which oil prices continue to be above the US\$ 60 a barrel mark and where fears about the amount of oil available to meet global demand given the current instability in the Arab world, politicians in countries such as the United States are anxious to find alternative fuels. Research to find alternative fuels has become an important issue in the United States and other developed countries. In the United States, for example, the Bush Administration has been spreading the message about the importance of promoting alternative fuels:

America is addicted to oil, which is often imported from unstable parts of the world. The best way to break this addiction is through technology... We'll fund additional research in cutting-edge methods of producing ethanol, not just from corn, but from wood chips and stalks, or switch grass. Our goal is to make this new kind of ethanol practical and competitive within six years¹ (United States, "State").

As this message by President George W. Bush encourages the United States to begin to invest more heavily in alternative fuels for the future and find solutions for the country's oil addiction, Brazil has already achieved these goals and today is advanced in the ethanol production as a fuel substitute. Ethanol in Brazil has become the answer to the country's dependence on oil and may offer a solution for the rest of the world. Sugarcane-based ethanol, or "*álcool*" in Portuguese, has been around as a fuel source since the 1930s. However, due to different economic setbacks in the country, changes in government policies, and the development of the industrial and agriculture sector, the ethanol program in Brazil has gone through very different stages since its start in 1975.

This thesis looks at what Brazil has done in the last 30 years to reduce its oil dependence and become an example to the rest of the world in developing ethanol as a substitute. The policy

¹ This message was given by President Bush at his State of the Union Address on January 31st, 2006. Since 2001, the U.S. Government has spent nearly \$10 billion to develop cleaner, cheaper, and more reliable alternative energy sources.

instruments implemented by the government and the partnership established with the private industry have given Brazil the formula for success in terms of energy independence. In fact, this work suggests that government policy has been an essential component for Brazil's successful ethanol program.

This thesis has three goals: 1) to reconstruct the development of Brazil's ethanol program over the last three decades, 2) to understand the current policies and those implemented since 1975, and 3) to determine what lessons can be learned for other countries. This thesis hypothesizes that Brazil's policies were a crucial component for the success of their ethanol program. Through examination of the events that influenced the Brazilian government's decisions, the reader is able to understand the challenges that Brazil faced since the beginning of the 1970s. Moreover, by analyzing Brazil's history since 1973, the reader is able to compare those times with today's political economy.

In addition to exploring the policy options already in place and those implemented over time by the Brazilian government, this thesis analyzes the program's outcomes and explains why the program has become successful. After looking at the Brazilian experience and highlighting its results, this paper examines how the Brazilian ethanol experience could serve as a model for countries in need of alternative fuels.

The research compares the current alternative fuel situation in the United States and Argentina to Brazil's by investigating the policies and paths that these countries have taken to alleviate their oil dependence. At the end, this thesis looks to find answers for two central questions: what lessons can be taken from the Brazilian experience and what role governments should take in order to create effective alternative energy programs.

The thesis and the approach to analyzing the content are significant for two reasons. First, the current energy challenges countries are facing have created numerous economic and environmental pressures. As a result, interest in developing new alternative fuel sources has increased dramatically. Therefore, understanding how Brazil created a successful ethanol program is significant in order for other countries to reduce their oil dependence.

For instance, the current oil dependence in countries such as the United States was just shown when oil giant BP announced the closure of the biggest oil field in the country on August 2006 because of excessive corrosion in its pipelines in Alaska² (Isidore). This decision placed more pressure to the already tight global oil market since it represented about half of a percent of the total global production (Isidore). Even though 400,000 barrels a day might not sound like much for the total global production, the current high dependence on oil has made the global economy more vulnerable to any shifts in supply. As a result, the average price for a gallon of unleaded gasoline in the United States for example was US\$ 3.03 in August. This was US\$ 0.021 short of the record high established on September 5, 2005, a week after Hurricane Katrina hit New Orleans (Isidore). This situation not only affected consumers at home, but the sharp increase in oil prices could seriously hurt financial markets, both directly or indirectly, many country's growth levels, and production costs for many industries. If governments, such as Argentina and the United States were to take a more serious approach to implementing policies that promote developing alternative fuel sources, oil dependence can decrease significantly and countries can avoid serious impacts on the economy.

Understanding Brazil's approach to alleviate its oil import bill since 1973 is also significant for global security. Even though energy independence has been a topic of discussion

² Alaska's Prudhoe Bay represents 8% of the United States' oil production (Isidore).

for many governments around the world, it was not until September 11, 2001 that this debate became more serious. The United States, for example, uses more oil than any other country in the world yet it only has 2.7% of the remaining global reserves (NET 3). In addition, countries such as China have begun to demand higher quantities of oil which has put more pressure on producing countries. Moreover, many of the oil producing countries such as Iran, Iraq, and Venezuela are not considered reliable suppliers due to political issues.

Sugarcane or corn-based ethanol is a renewable fuel source that could reduce oil imports for countries such as the United States. For instance, today ethanol provides only about 3% of the United States' transportation fuel (Sandalow). In contrast, ethanol in Brazil provides more than 40% of the transportation fuel (EIU, "Ethanol-fuelled"). Therefore, if countries such as the United States are looking for ways to reduce foreign oil dependence from unstable or unfriendly governments, officials should look at the Brazilian experience over the last thirty years. Understanding all aspects of the Brazilian ethanol program is important because it could serve as an example for other countries to create an energy plan able to provide reliable fuel resources which can help a country become more secure and independent.

Literature Review

The ethanol program in Brazil dates back to the early 1970s. As a result, all the literature found for this research can be divided in two categories. First is the literature from the 1980s and 1990s that describes the economic challenges faced by Brazil and the reasons why a national ethanol program was pursued. The second part of the literature review dates from the year 2000 and to the present. This literature explains the current stage of the Brazilian ethanol program and the challenges countries around the world are facing because of the sharp increase of oil prices.

In the mid 1980s, literature from researchers and Brazilian government officials evaluating the National Alcohol Program's (PNA) results was very extensive. The books and documents

that reflected on the ethanol program during this decade discussed its social and economic benefits for Brazil. The analysis from the 1980s sees the PNA as an important program for the country's future, but lacks a global perspective. Among the literature in English about the program in its early stages was Ethanol, Employment and Development: Lessons from Brazil by Armand Pereira. The author analyzed the Brazilian ethanol program from its inception in 1975 to 1986. He identifies the importance of this program for Brazil to substitute oil and alleviate its economic challenges. Pereira explains the history of the ethanol program, the policies implemented, and the benefits obtained, as well as the challenges faced. The author considers other countries that initiated some production of ethanol at the time, but fails to explain the approach taken by the other countries.

Brilhante (1997) also provided an excellent background of the history of ethanol in Brazil. He described and analyzed the motivations and events that propelled the Brazilian government to create the PNA. His paper also explains the issues that increased the skepticism of many Brazilians late in the 1980s and throughout the 1990s. The author concludes that ethanol has been an ad hoc response to a set of circumstances and downplays the Brazilian government's initiatives.

Literature from the Brazilian government and institutions interested in endorsing ethanol is useful to understand the way the program was promoted. Books from the National Alcohol Commission and Ethanol and Sugar Union of São Paulo put into context the importance of ethanol not only for Brazil, but for the sugar producers that faced constant fluctuations in the international markets. Programa Nacional do Alcool – Proálcool and Alcohol: A Sustainable Fuel Story from 1983 and 1997 respectively explain the ethanol process and the benefits for the country and the agro-industry. These reports provided information to help understand the role of

the government and the agro-industry towards the end consumers, that is, the way they marketed the program to the everyday Brazilian.

An analysis of the historical context in which the ethanol program was created is extremely relevant for this thesis because it allows the reader to compare the situation in the 1970s to the current one. Moreover, by understanding what Brazil faced over the years, an assessment on the policies implemented by the government becomes more comprehensible. The literature from the 1980s and 1990s explores not only the beginnings of this program, but it describes the policies created over time, the results obtained, and various perspectives from Brazilians. These books or articles provide the necessary background to evaluate the performance, understand the challenges, and the opinions of people involved in the early stages of the PNA. Writers such as Jonathan Kandell provided an excellent perspective of Brazilians in 1989 when the industry was going through its most difficult stage. In his article for *The Wall Street Journal* entitled “*Brazil’s Costly Mix: Autos and Alcohol – Alternative Energy Plan Falters as Oil Prices Fall*”, Kandell was able to obtain various opinions from people such as Antonio Delfim Netto³. This information allows this research to understand the reasoning behind much of the policies implemented, as well as to provide both the positive and negative thoughts of Brazilians about the PNA. At the end, this information describes the conditions and criticism that the Brazilian government faced. This can be compared to what countries such as the United States are currently going through while developing an alternative fuel program.

The 1990s were critical for Brazil’s ethanol program. Consumer skepticism increased and the government’s PNA lost much support; accordingly, the topic did not receive much attention in newspapers and historical analyses. Low oil prices and increased sugar prices in the

³ Former Planning Minister who supervised the expansion of the PNA in 1980.

international market were two of the main factors that hurt the PNA in this decade. Now that oil prices are back on the rise, new literature has started to emerge. In the last four years, newspapers from all over the region are filling pages with stories about the Brazilian ethanol experience. Articles from The New York Times, The Wall Street Journal, The Economist, O Globo, BBC News, and many others are making people aware of the alternatives a country like Brazil has been able to produce. Even Luis Inácio Lula da Silva, President of Brazil, wrote an op-ed for the Wall Street Journal in July 2006 entitled “*Fuel for Thought.*” In this article, President Lula explains the importance of ethanol in this modern era and emphasizes the need of cooperation among countries to expand ethanol production and meet global demand.

Other reports from agencies such as the Inter-American Institute for Cooperation on Agriculture (IICA) and the Argentine Institute of Agricultural Technology (INTA) are also voicing the importance of biofuels⁴. Biofuels in Latin American by INTA and Perspectives on Biofuels from Argentina and Brazil by IICA and the Argentine Secretariat of Agriculture, are two recent reports that cover the current need for alternative fuels in Latin America. They both concentrate on what countries in the region are capable of doing to reduce their dependency on oil if the right policy instruments are implemented.

A second body of literature is of great help for this thesis. As the history of the ethanol program is analyzed, questions arise about why other countries did not take the same approach Brazil took three decades ago. Now that high fuel costs are affecting the global economy, literature from the year 2000 to present concentrates on recounting the work by the Brazilian government to obtain energy independence and reduce the use of oil fuels. Moreover, as

⁴ Any renewable fuel derived from biomass or agriculture products such as corn, soybeans, sugarcane, palm oil, and others.

countries around the world start to set policies to promote alternative fuels, the most recent books and articles about ethanol show how Brazilians adapted to challenges that they faced over time.

Thesis Approach

Ethanol has become the “life and business”⁵ of Brazil according to Luiz Fernando Furlan, who was Brazil’s Minister of Development, Industry, and Foreign Trade in 2002. This thesis examines the role that the Brazilian government played in creating an alternative fuel industry that now serves as an example for the world. This project explores the reasons why the Brazilian government created the PNA, the government’s role in this industry, the main issues and challenges the program faced throughout the years, and the results of government policies that were implemented over the years for the development of the ethanol industry. Finally, it looks into what other countries are currently doing compared to Brazil in order to reduce its oil dependence.

Ethanol has become extremely important not only because of current high oil prices, but also due to its ability to help country’s finances and push for economic development. The second chapter, “History of Ethanol in Brazil”, examines the circumstances that the Brazilian government faced when it first created the PNA in 1975. During the first oil shock of 1973, oil accounted for almost half of the primary consumption of energy in Brazil. Since about 80% of the country’s oil need in that time was imported, the government looked for a comprehensive solution to the crisis. The chapter also concentrates on what the country was going through during the periods of the 1970s, 1980s, 1990s, and its current state in the new millennium, as well as the different stages and challenges the ethanol program faced.

⁵ Minister Furlan has been a vocal proponent of the idea that ethanol offers Brazil a chance to improve the environment while creating new jobs and saving money for consumers. This was the message by Furlan speaking in the Lounge of the Women’s Faculty Club at the University of California, Berkeley, on April 20th 2005.

The third chapter, “Policy Instruments”, assesses the different tools used by the Brazilian government to promote the program. According to the New York Times: “Brazil’s path has taken 30 years of effort, required several billion dollars in incentives and involved many missteps” (Rohter). This is precisely what happened in Brazil and what the chapter analyzes. The government has taken different measures in order to promote the industry. However, as history shows, the PNA went from very successful years to times where public skepticism almost brought it to an end. Currently, the use of ethanol in Brazil has been accelerated in the last three years. This is a result of the different policies and incentives the government has implemented, as well as the partnership both the government and the private sector have developed over the years. With the introduction of *flex-fuel* engines⁶, the ethanol industry has become more important than ever for Brazil and eventually the world. The policies and incentives mandated by the Brazilian government throughout the years are the main theme of this chapter.

The fourth chapter of this thesis concludes the analysis of the Brazilian experience and the role of the government with the ethanol program. This chapter summarizes how government policies can play an important role for the development of programs like the PNA in Brazil. Furthermore, considering that oil prices and supply have become a serious issue due to geopolitical problems or unstable governments, this chapter looks at what other countries are currently doing and what they should take from Brazil. One of the two countries this chapter considers is Argentina. Fossil fuels in this country are a dominant source of energy. These resources represent 88% of the country’s energy supply (Rubio 6). Among the varieties derived from fossil fuels, diesel has a market share of 48% and is most commonly used among the cargo transportation industry, the agriculture sector, and public transportation (Rubio 6). Currently,

⁶ Engines designed to run on pure hydrous ethanol, pure gasoline, or a blend of gasoline and anhydrous ethanol.

there is a demand for diesel in Argentina of about 12.4 million cubic meters per year and by 2010 the demand should reach about 15 million cubic meters (IICA/ SAGPyA 26). However, there are concerns about the availability of these resources since it is estimated that Argentine oil reserves will last 9.1 years and 10.2 years for natural gas (IICA/ SAGPyA 26). As a result, biofuels have become very attractive as an alternative source of fuel for this country, and as of April 19th, 2006 its Congress approved a Biofuels Law to promote the production of biodiesel and ethanol.

The other country this chapter covers is the United States. As the highest oil consuming nation and importer in the world, the current energy crisis is of major concern. Gasoline and diesel represented about 98% of the transportation fuel sold in 2004 (Bush 1). Currently, “U.S. motorists’ demand for gasoline is now approaching 380 million gallons a day” (Bush 1). As a result, the United States is indeed in a position where policies aimed at the promotion of alternative fuels must be implemented for its national security and its economy. This is where the Brazilian experience with its ethanol program can guide the United States. This chapter looks at what the United States has done recently to alleviate its oil dependency and what it can take from Brazil either by looking at previous or current policies or through cooperation among the two countries.

The final chapter serves as a conclusion for this research. This fifth chapter covers the findings obtained while looking at the several policies implemented by the Brazilian government and its significance. After analyzing the history and the results obtained in Brazil with its ethanol program, it is important to understand if the steps taken by Brazil really serve as a model for the rest of the world. In this era of high oil prices and new environmental challenges due to issues such as global warming, alternative fuel programs must be taken seriously. Finally, this

chapter looks at the end result of the ethanol experience in Brazil. The program has gone through various stages through its three decades of history; therefore looking at its outcomes can be a guideline for the future.

CHAPTER 2 HISTORY OF ETHANOL IN BRAZIL

First Oil Shock in Brazil (1973)

The first oil shock quadrupled the price of petroleum. Brazil relied on imports of oil close to 80% of the country's consumption. The oil shock raised the country's total import bill from US\$ 6.2 billion in 1973 to US\$ 12.6 billion in 1974. In addition, the Brazilian trade balance changed from a small surplus in 1973 to a deficit of US\$ 4.7 billion in 1974 and a current account deficit from US\$ 1.7 billion to US\$ 7.1 billion (Baer 87) (Table 2-1).

In 1974, Brazil produced 177,000 barrels a day of petroleum and had reserves for 12 years compared to 1 billion cubic meters a year of natural gas with reserves for 20 years (Pelin 101). By 1979, Brazil's production structure of primary energy was approximately 14.5% from non-renewable sources compared to 85.5% from renewable sources (Pelin 90). Out of the total non-renewable sources produced in Brazil, 9.7% was oil (Pelin 90). Since 41.5% of Brazilians' energy consumption was based on oil, Brazil had to import the difference (Pelin 92). The imports of oil from foreign markets indeed put Brazil in an unfavorable situation. By 1979, the gross foreign debt had reached US\$ 49.9 billion (Baer 92) (Table 2-2).

Even though the country was facing this difficult situation, the Brazilian government led by General Ernesto Geisel, opted to continue to increase the country's growth levels. The objective was to follow the "economic miracle" years presided by President Emílio Garrastazú Médici⁷ when real GDP had grown at annual rates of 11% and when inflation had been brought to its lowest level since the 1950s. General Geisel's government, who came to power in March 1974, had two main goals: improvements of income distribution and continued high growth rates

⁷ Médici governed from October 30th, 1969 to March 15th, 1974. His presidency was characterized by how the political repression by the Brazilian military government reached its height.

of the Médici government. However, Geisel faced various economic and political difficulties that announced the end of the “economic miracle” in Brazil and threatened the military regime.

By the end of 1973, the foreign debt surpassed US\$ 10 billion and by 1974 inflation reached 34.5% (Dubeux). As a result, a significant policy response occurred in 1975 when the government decided to push economic growth with the introduction of the Second National Development Program (PND II, 1975-1979) (Appendix A). This program consisted on massive investments in the energy sector in order to decrease the dependence of external energy sources and reach growth levels of 12% by 1979. The ways to achieve the predetermined levels of growth included:

- Import substitution of basic industrial outputs (such as steel, aluminum, copper, fertilizers, and petrochemicals) (Baer 88).
- The rapid expansion of the economic infrastructure (hydro and nuclear power, alcohol production, transportation, and communications) (Baer 88).

Under the PND II, many of the investments were undertaken by state enterprises. The private sector carried out investments such as capital goods and in many cases they were supported by the Brazilian Development Bank⁸ (BNDES). This program and its funding acted as a countercyclical policy in order to maintain reasonable rates of growth and employment that were affected by the impacts of the first oil shock. The PND II aimed at increasing the country’s self-sufficiency in important sectors such as energy.

Reaction to the First Oil Shock

With the challenges that Brazil faced in the early 1970s due to the first oil shock and the reduction of the price of sugar in the world market between 1969 and 1974, the government was forced to look for solutions. In an attempt to improve the balance of payments and reduce its oil

⁸ The BNDES is a federal public company that is associated to the Ministry of Development, Industry and Foreign Trade, which has as an objective to long term financing of endeavors that contribute towards the development of the country.

dependence, the Brazilian government created the National Alcohol Program (PNA). This program aimed at taking full advantage of the sugarcane production to produce anhydrous alcohol as a gasoline blend and hydrous alcohol as a full substitute for gasoline.

Hydrous ethanol and anhydrous ethanol are two types of fuels with different uses and they involve different implications for planning and development. Hydrous ethanol is 94% water-free and anhydrous ethanol is about 99.8% pure. This is a very important distinction not only because of different uses, but also because the step that involves removing all water to make anhydrous ethanol requires an extra distillation column⁹ in the production process. This extra step raises the cost of production of anhydrous ethanol by 5% to 9% (Pereira 13). However, earlier studies in Brazil and in the United States have concluded that blending anhydrous ethanol to gasoline improves performance and saves energy (Pereira 14).

Anhydrous ethanol can be blended with conventional gasoline in amounts of up to 20% to 25% to make “gasohol” for car fuel without any adaptations to the engine. This mix increases the octane content of gasoline, prevents pre-ignition, and replaces tetra-ethyl lead. It is also important to point out that after years of experience and testing, Brazil has shown that the energy gain from the mixes with anhydrous ethanol depends on the quality of gasoline mixed. In the case of hydrous ethanol, this type of fuel can be used only as a straight fuel in cars with hydrous-ethanol engines. Yet, the fuel efficiency of these types of cars is 17% to 18% lower than gasoline vehicles. There are also other considerations that these types of ethanol fuels present to both consumers and producers. Hydrous-fuel vehicles cannot run on gasoline nor on gasohol; meaning that the owners of these cars could not use gasoline as fuel in the event that world oil prices and the cost of gasoline were to decrease significantly.

⁹ Typically, the process of making hydrous ethanol uses two or three distillation columns.

Early Years of the National Alcohol Program (PNA)

The PNA in 1975 was mainly intended to reduce Brazil's oil imports; however, it also provided some other direct and indirect effects. The creation of jobs and environmental improvement were some of the benefits of this program. In addition, this industry created a huge domestic demand for Brazilian sugarcane and lifted the Brazilian sugar industry once more. The PNA provided the needed assistance for its sugar producers who had faced constant problems of overproduction and price fluctuations.

The Brazilian government launched the PNA even though the unit cost of ethanol was substantially higher than gasoline in 1975. It was not until the second oil shock in 1979 that the average barrel of ethanol produced in Brazil became more economically competitive. For instance, the average economic cost difference in 1979, 1980, and 1981 to produce gasoline compared to anhydrous ethanol was US\$6.2, US\$6.2, and US\$6.1 cheaper respectively¹⁰ (Pereira 69). Therefore, it was clear that the decision to create the PNA in 1975 was not purely made on the basis of the relative costs of gasoline and ethanol, but also on the uncertainties of market trends of oil and sugar, foreign currency savings, employment, income distribution, and the development of a capital goods sector. According to Armand Pereira, the Brazilian government and entrepreneurs were able to look at other important factors that attracted them to invest in the industry:

- Ethanol in Brazil had already been produced starting in the 1920s and it was used for both fuel and non-fuel purposes. The technology to produce ethanol was well known; as a consequence the country's sugar mills were able to annex ethanol distilleries to their facilities (Pereira 2).

¹⁰ This price difference includes refinery costs, distillery production costs, distribution costs, and Brazilian government subsidies costs for ethanol production.

- Due to the low sugar prices in the international market in the 1970s, ethanol production among sugar entrepreneurs saw this as an opportunity to generate extra revenues (Pereira 2).
- Brazil's massive area of land resources did not restrain the production of sugar and ethanol. The government understood that the production of ethanol would not interrupt any supply of sugar to meet domestic and international demand (Pereira 2).

The PNA, initially supervised by the National Alcohol Commission, had four main objectives:

- Savings of foreign exchange as a result of oil-import substitution.
- Reduction of disparities of income among regions and individuals.
- Growth of national income through the deployment of underutilized resources, particularly land and labor.
- Growth of the capital goods sector through the rising demand for equipment with a high level of national participation (Pereira 49).

Overall, the program had a slow start and the decision-making process was very inefficient until 1979. One of the issues at the beginning of the program was the little information or back-up research to guide the decisions by the commission. Many of the decisions made in the first five years for project proposals were made without strong foundations:

During 1978, alcohol distillery projects were approved with possessed estimated internal rates of return varying from 1% to 78%. This discouraging scenario led to the first major effort at assessing PNA, financed by the National Research Council, to decry "... a total lack of policy-making capacity within the PNA" (Pereira 49).

These issues within PNA and the rise of oil prices in 1979 led Brazilian President João Figueiredo to issue an executive order in July 1979 intended for strengthening the institutional base of this program. Among the changes imposed by the President, the National Alcohol Commission was replaced with the National Alcohol Council. In addition, an Executive Committee was created to provide technical support to the Council, as well as to encourage alcohol-related research. However, Brazil was not entering the 1980s with strong indicators. By

1979, the country had a balance of payment deficit of US\$ 2.8 billion and oil imports had increased to US\$ 6.7 billion in the verge of the second oil crisis (Baer 88). Along with the debt crisis of the 1980s, PNA was about to face new challenges.

Second Oil Shock and the Debt Crisis

By the second oil crisis in 1979, the Brazilian economy was extremely vulnerable to changes in external conditions. Since 1973, Brazil's terms of trade were deteriorating and led to the reduction of national income levels. As a result, the Brazilian government opted for a strategy that avoided decreases in consumption and domestic investment in order to continue the levels of growth of the "economic miracle" years. This strategy involved an ample import substitution program in the capital and intermediate goods sector through strong fiscal and credit incentives, as well as high amounts of investments by state-owned enterprises.

Brazil was able to maintain high growth levels during the second half of the 1970s. This success was accomplished primarily by government intervention with investment programs such as the PND II. The government made sure that investments and external credit availability were accessible in order to avoid a period of stagnation. This continued inflow of external financing to fund investments resulted in an enormous increase in foreign debt¹¹. By 1978, Brazil's gross foreign debt reached US\$ 43.5 billion (Baer 92).

In 1979, the second oil shock nearly doubled the price of imported oil to Brazil and lowered its terms of trade even further. In addition, the rise in international interest rates due to new restrictions of U.S. monetary policies increased Brazil's balance of payments problem and the size of the foreign debt. Between 1979 and 1980 Brazil's gross foreign debt rose to US\$ 49.9

¹¹ The international financial markets were very liquid after the first oil shock. International banks flush with petrodollars were able to make loans at low interest rates. Brazil was able to easily justify its increased international borrowing in those years. The average cost in real terms for international borrowing between 1974 and 1978 were 13.4%, 5.9%, 6.7%, 6.9%, and 5.7% respectively.

and US\$ 53.8 billion respectively (Baer 92). The initial impacts of the higher oil prices together with high external debt servicing obligations created extreme problems to the already unstable public sector of Brazil. Also, the accelerated inflation rates¹² in the country and the 1982 Mexican debt crisis, which ended Brazil's access to international financial markets due to doubts about the future health of the country's economy, created increasing pressure for economic adjustment. A period of stagnation starting in 1981 extended through the entire decade of the 1980s. The GDP in Brazil declined by 4.4% (Baer and Mueller) in 1981 and this became known as the "Lost Decade".

The policies enacted by the Brazilian government¹³ in 1980 seemed to run counter to what was needed for balancing accounts. The expansionist policies by the government resulted in the massive increase of the foreign debt and a strong acceleration of inflation. By 1981, the policies were abandoned and replaced by a policy based on high interest rates and currency devaluation designed to encourage the inflow of foreign capital. This contributed to the economy recession of the 1980s.

The country experienced other severe problems during the "Lost Decade". Increased tax evasion resulted from both a complex taxation structure and the rise of the informal sector in several segments of the economy. In addition to the critical revenue situation, expenditures increased from 9.9% of the GDP in 1980 to 14.3% in 1989 (Barbosa and Macedo 5). The Brazilian government's financial commitments also increased dramatically. Total financial expenditures jumped from 0.63% of GDP in between 1970 and 1978 to 3.5% of GDP between 1988 and 1989 (Barbosa and Macedo 5). This situation resulted largely from the domestic and

¹² Between 1980 and 1985, the rise in the GPI had escalated from 86.3% to 248.5% annually (Baer and Mueller)

¹³ This government was led by General Figueiredo, the last military president in Brazil who took office in March, 1979.

foreign debt accumulation. The government savings ended up reducing significantly over the years from 7% of GDP in the early 1970s to negative values in between 1987 to 1989. Indeed, the public sector's continuous structural disequilibrium and the interruption of its financing resources were clearly the consequences of the inflation problems and the overall stagnation of economic production during the 1980s.

Institutional Crisis for the PNA (1979 – 1981)

The challenges brought by the debt crisis and the second oil shock created a period of reforms starting 1979. Between late 1979 to the end of 1981, the PNA went through an institutional crisis in which the government needed to set new goals, new responsibilities, and adjust the future of ethanol in Brazil. This second phase for the PNA insisted in using hydrous alcohol as a full substitute for gasoline. As a new objective, the new goal was to produce 10,700 million liters of alcohol by 1985¹⁴ (Pereira 78). Yet, the expansion of production was to be based in autonomous distilleries in order to concentrate in the production of hydrous ethanol. The idea was to reduce oil consumption and increase the demand for a fuel produced at home. There were other goals established in 1979: The production of 900,000 new hydrous ethanol cars and 270,000 gasohol cars to be converted to hydrous.

By 1980, production of anhydrous and hydrous ethanol reached 3,500 million liters¹⁵ (22.6 million barrels¹⁶) (Pereira 53). Furthermore, about 253,000 hydrous ethanol cars were produced, 30,600 gasohol cars were converted to hydrous ethanol, and some light vans and tractors also fuelled by hydrous ethanol were introduced on the market (Pereira 53). This first year after the

¹⁴ 6,100 million liters of hydrous ethanol, 3,100 million liters of anhydrous ethanol, and 1,500 million liters of alcohol for non-fuel purposes.

¹⁵ This represented a 6% of total consumption of oil in 1980.

¹⁶ According to Pereira, one barrel of ethanol is equivalent to 159 liters (Pereira 151).

reforms showed positive results for the government and the automobile industry for ethanol production. Consequently, both the government and automobile companies agreed to double the production of hydrous-ethanol cars in 1981 and to increase the production of hydrous ethanol. Although the government and the automobile industry were committed to the program's expansion, new challenges in 1981 brought difficulties for the PNA.

As a result of the high numbers of hydrous-ethanol cars projections, together with new policy instruments by the government, the production of hydrous ethanol increased from 540.6 million liters (3.4 million barrels) in 1979 to 1,128.9 million liters (7.1 million barrels) in 1980 (Pereira 150). However, the consumption of ethanol as a fuel by Brazilians between 1979 and 1980 increased from 318 million liters (2.0 million barrels) to 429.3 million liters (2.7 million barrels) respectively (Pereira 92). The consumption of ethanol was mainly affected by the mixed results regarding the performance of hydrous-ethanol cars. This situation hurt consumer's confidence towards ethanol and it also resulted in a reduction of hydrous-ethanol car sales. In 1980, 240,700 cars were sold compare to only 137,200 cars in 1981 (Pereira 55).

Towards the end of 1981, views about PNA's effectiveness became even less positive. Furthermore, the improvement in the world sugar prices in 1980 created uncertainty about future supplies of sugarcane ethanol. Other events such as the temporary suspension of the sugar export quotas and comments by policy makers in the late 1980 and early 1981 about restrains on growth levels of raw materials and ethanol supplies, indicated possibly ethanol shortages and created a temporary bad image for the PNA.

A Period of Adjustment for the PNA

In this period of adjustment, from 1982 to 1985, the ethanol program began to gain back the confidence of consumers after the program's institutional crisis in 1979 through 1981. This was the result of new commitments by the government, better public relations, and technological

improvements in hydrous-ethanol cars. Also, new reduction in the world sugar prices, as well as the consumer incentives set by the government helped the PNA to become more visible again.

Other events in 1982 helped restored the confidence by Brazilians about the PNA. First of all, according to Pereira the conversion of cars from gasohol to hydrous-ethanol increased to about four times higher compare to 1981 as a result of the new incentives. Sales of hydrous-ethanol cars also increased in 1982. Moreover, the production of ethanol increased by 15% compared to 1981; which resulted in the announced by the government that the 1985 target of 10.7 million liters was deferred until 1987 to avoid overproduction. Lastly, due to lower tax rates for consumers to purchase hydrous-ethanol cars, the vehicle's value became six to seven percent cheaper than gasohol cars and about 40% cheaper if used as taxis (Pereira 57).

By 1984, ethanol consumption reached to about 10% of the actual demand for oil products¹⁷. This increase represented a consumption of 38 times higher compared to the early years in 1976. This helped the Brazilian balance of payment situation by creating a foreign exchange saving of US\$1.2 billion (Brilhante 438). Moreover, the sale of alcohol-fuelled vehicles kept increasing. By the end of 1984, these cars accounted for 73.5% of the total new car sales (Table 2-3).

This third phase of the PNA also helped gain market share in the industrial sector. The reduction in the consumption of oil products and natural gas was impressive. In 1979 the industrial sector consumed 17.3 million tons of oil equivalent and by 1984, only 9.7 million oil equivalent. Certainty, the use of ethanol from sugarcane as a fuel allowed Brazil to lessen its dependence on oil and helped alleviate other economic problems. However, the PNA still

¹⁷ Consumption of ethanol reached 6.6 billion liters in 1984.

experienced difficult times due to other factors that came along during the late 1980s (Brilhante 439).

New Challenges During the Lost Decade

By 1983, nine out of every 10 new cars sold in Brazil ran on ethanol alone¹⁸ (Luhnow and Samor). Ethanol and ethanol-powered vehicles became very popular due to government price supports that made the fuel 35% cheaper than gasoline at the pump. However, by 1985 the PNA was a mature program with serious problems that created new challenges for the industry and the government. These problems were in part related to the Brazilian debt crisis that led to the dried up sources of finance, followed by the declining international oil prices that started on 1986.

Moreover, Brazil throughout the 1980s or the “Lost Decade” was going through some critical economic times. Factors such as the country’s economic recession and high inflation; as well as the increase of international prices of sugar, the continued fall in international prices of oil, political struggle to balance the supply and demand for alcohol and gasoline, and cut of the subsidies to the program, created more difficult times for the PNA. According to Ogenis Brilhante, the program went from a period of overproduction to a situation of deficit. Furthermore, in several regions of the country the distribution system were seriously affected and consumers had serious difficulties in getting alcohol to fill the tanks of their cars (Brilhante 439).

This period of new challenges for the PNA due to both domestic and external factors created an environment of constant criticism towards the program and the government’s role. It was a time where hyperinflation and the decrease of oil prices made very difficult for the government to keep the ethanol price below gasoline. Government spending was also cut due to

¹⁸ The Wall Street Journal, January 9th, 2006.

the urge by the International Monetary Fund (IMF) and other creditors; which led President José Sarney to reduce ethanol price support.

Car production was also affected by this situation. As a result of fears by the consumers about alcohol supplies and difficulties to obtain fuel for their ethanol-powered vehicles, ethanol cars were affected as a percentage of new cars produced. By 1988 alcohol-powered cars represented 63% of total new cars produced, but by 1989 and 1990 their percentage fell to 47.3% and 10.8% respectively (Table 2-4). This was not only a crisis of supply for the PNA, but also a crisis of consumer confidence.

Supply of ethanol was also an issue that created problems for the PNA during the late 1980s and mid 1990s. In 1995, Brazilian alcohol production did not meet the national demand. In that year, 13.1 billion liters of alcohol were produced from 62% of the sugarcane crop and 1.8 billion liters were imported (Brilhante 441) (Table 2-5). Also in the 1990s, many distilleries started to incorporate sugar mills into their existing installations in contrast to the period of 1975-1979. This was a way that sugar companies continued making the fuel at reduced costs in a period where state support dried out. Consequently, 67% of the alcohol produced in 1995 came from annexed ethanol distilleries and 33% came from stand alone distilleries (Brilhante 439).

As the PNA struggled during the 1980s and through the mid 1990s, people skeptical of the future of the program criticized the planning by the government. The PNA was created in a time where oil prices were close to US\$35 a barrel and a decline in prices was not foreseen. The Brazilian government seemed to not have done enough strategic planning to control a situation in relation to the oil market such as in the late 1980s. When oil prices were around US\$20 in 1986, the ethanol program generated a US\$2.7 billion annual deficit for the government¹⁹. Even

¹⁹ This was a study done by the World Bank (Kandell).

Werther Annicchino, former president of Copersucar, the largest alcohol-production corporation, conceded that if the market were allowed to determine prices, “ethanol could not compete with gasoline” (Kandell). However, there were also other supporters like Antonio Delfim Netto, a former planning minister who supervised the expansion of the PNA during its expansion in 1980, who recommended freezing production to 4 billion gallons a year and continuing research to cut ethanol’s manufacturing cost in order to become more competitive with gasoline:

If oil prices jump again as is likely in the next decade, we will (Brazil) look like geniuses (Kandell).

The Brazilian Economy in the 1990s

After very difficult times during the 1980s and half a century of inward-looking economic growth, the 1990s became a period where new reforms were needed in order to put the country’s economy back on track. Even though some action took place in the late 1980s with foreign trade liberalization and early privatization, it was not after 1990 that significant steps were taken by the Brazilian government.

The basic recipe of reforms to battle the economic misfortunes of the country was known as the Washington Consensus. Among the steps that were encouraged by international agencies such as the International Monetary Fund (IMF) were: fiscal discipline, tax reforms, providing competitive exchange rates, securing property rights, deregulation, trade liberalization, privatization, elimination of barriers to foreign investment and financial liberalization (Baumann 3). The process of reforms in the 1990s was divided in two generations. The first generation began in the early 1990s with trade policy reforms and a movement to privatize public assets. The second generation of reforms did not begin until 1994 and it involved social security and administrative reforms, regulation of the financial sector, a series of changes in a number of social programs, as well as more openness to foreign investment and privatization.

The immediate economic challenges of Brazil; hyperinflation and an almost bankrupt public sector, made Fernando Collor de Mello's²⁰ administration introduced a stabilization plan and a set of reforms which involved some of the recommendations of the Washington Consensus. Among the tools used in this stabilization plan were an eighteen month freeze on almost all private sectors' financial assets, price freezes, and the abolishment of indexation²¹. The administration also introduced provisional taxes to deal with the fiscal crisis and closed several public agencies in order to reduce expenditures (Baer and Mueller). At the end, the goals behind these measures were indeed to reduce inflation and lower inflationary expectations.

Trade liberalization started in 1987 but in 1990 the government accelerated the phasing-down of tariff rates. The average tariff in Brazil between the years 1991 to 1993 was 17.8% compared to 33.4% between 1988 to 1990 (Baumann 8). Moreover, trade reforms in 1990 also included the elimination of non-tariff barriers and a number of incentives to export. However, even though President Collor de Mello implemented these new reforms, few of his programs succeeded in the stabilization of the economy. This was mainly because of management errors and the inability to secure political support (Baer and Mueller). Even though inflation fell by more than 80% in March 1990, it began to increase again. In January 1991, it rose by 19.9%, reaching 32% a month by July 1993. Together with political instability during Collor de Mello's two years in power, Brazil's real GDP in 1991 was 1% and -0.3% in 1992 (Baumann 10).

After President Collor de Mello impeachment in September 1992 on corruption charges, Vice President Itamar Franco became President until 1994. Inflation was still a problem and in 1993 even though the economy grew again, inflation rates were higher than 30% a month. It was

²⁰ Fernando Collor de Mello was the first post-military-regime president elected by popular vote who got to office in March 1990.

²¹ Price adjustment which allows capital or income to take account of or benefit from inflation.

not until 1994, led by then Minister of Finance Fernando Henrique Cardoso, that the government developed a new stabilization plan that it involved the introduction of an equilibrium budget mandated by the National Congress, a process of general indexation, and the introduction of a new currency, the *real*, pegged to the U.S. dollar. This was the beginning of the second generation of reforms in the 1990s.

Fernando Henrique Cardoso was inaugurated President in January 1st, 1995. His administration instituted more drastic reforms for the new stabilization plan which linked Brazil more aggressively to the world economy. The Cardoso administration pushed for more privatization. In 1991 to 1994 only 32 firms were privatized, providing total revenues of US\$ 8.6 billion (Baumann 10). This first step in privatization involved the manufacturing sector; all relevant state-owned enterprises in steel, petrochemical, and fertilizer sector. After 1995, the process became more significant for the country. In 1991 to 1998, the total revenues from the privatization program were US\$ 58 billion from federal government companies and US\$ 29 billions from local state firms (Baumann 10)²².

The recovery of domestic activity through trade liberalization and the privatization program led to the increase of foreign direct investment (FDI). Between 1990 to 1993 flows of FDI to Brazil were about US\$ 900 million. Then between 1994 to 1998, FDI increased from US\$ 2.2 billion to US\$ 26 billion respectively (Baumann 10). These new reforms helped finance part of the Brazilian current account deficit; however, other government programs funding were cut in order to reduce expenditure. Among them, research and development programs were reduced affecting the ethanol industry in the 1990s.

²² According to Renato Baumann, this privatization program was among the biggest process in the world. The reasons behind the program was indeed to improve efficiency and to improve Brazil's fiscal situation.

With the increase of foreign competition and government funding reduction, most firms in areas such as manufacturing, energy, and agriculture underwent a process of rationalization of production in the early 1990s in order to face the challenges of a new market economy. This new market reforms made producers find ways to become more efficient without the assistance of the Brazilian government in order to stay competitive:

Until the late 1980s scientific and technological policy in Brazil was concentrated in building up infrastructure for R&D... In the 1990s the institutional structure related to innovation and research has undergone several changes, mainly due to the reduction of the role of federal government: in 1990 it was responsible for 73% of the investment in research and development of new produces; in 1997 that share had been reduced to 64% (Baumann 15).

The 1990s brought a fresh start for Brazil through the reforms taken to put the economy back in track. Even though Brazil did face more challenges late in the decade because of the effects of the Asian Crisis in 1997, the country was able to control inflation and made significant steps to link the country to the world economy. As a result of these new reforms, the ethanol program also went through changes. Since funding for the ethanol program were limited due to the new reforms in the 1990s, many producers needed to adapt to this new situation. Many producers were able to find ways to minimize costs which continued to push the ethanol program's objectives to the 21st century.

Current Stage of the Ethanol Program

After a long history of success, failures, and commitments by the government, the ethanol program in Brazil is now enjoying a very positive period. Just like Antonio Delfim Netto mentioned back in 1989, Brazil now looks like a genius. The country is now known as the biggest consumer and producer of ethanol in the world. As of 2005, according to Luiz Fernando Furlan, Brazil currently has six millions hectares devoted to ethanol production from sugarcane.

However, Embrapa²³ suggests that there is the potential for up to 90 millions hectares of sugar cane that could use for the production of ethanol. The capacity by Brazil to produce ethanol, in addition to current high oil prices, suggests that the investment made throughout the years is starting to bring dividends back for Brazil.

After the challenges the PNA went through up to the mid 1990s, the government made some radical reforms for the program between 1997 and 1999. Two of the major reforms taken by the government were the liberalization of the price of hydrated ethanol in 1997 and the price liberalization of anhydrous ethanol in February 1999. Furthermore, the distribution monopoly of ethanol given to Petrobras by the government was eliminated together with a reduction in the subsidies for producers²⁴. This was the beginning of a liberalized ethanol industry where the only tool of regulation left for the Brazilian government is setting the anhydrous blend ratio to gasoline. The actual percentage of the blend ratio is determined by the Ministry of Agriculture; in which they now are able to have a better control between the supply and demand of sugar and ethanol.

The production of ethanol in Brazil, according to Plinio Mário Nastari²⁵, has increased from 0.55 billion liters to 15.3 billion liters from 1975 to 2004. In 2004 alone, the production of hydrous ethanol was 7.12 billion liters and 8.14 billion liters of anhydrous ethanol (Nastari) (Figure 2-1). The use of ethanol in Brazil has now become a very important part in the energy sector on Brazil: As of 2005, 53.6% of ethanol has been used for the transportation system in

²³ The Brazilian state's Agriculture Research Corporation

²⁴ Subsidies paid to hydrous-alcohol producers were reduced from 0.98 reals per liter to 0.45 reals per liter (Buzzanell et al. 129)

²⁵ Representative from Datagro (Information Services on the Sugar and Ethanol Industries). This statistics were given at a conference in the Brazilian Ministry of Foreign Relations in Brasilia on December 2nd, 2004.

Brazil and as a gasoline substitute for vehicles²⁶. This is extremely high compared to the second largest producer of ethanol, United States, which only 2.2% of the ethanol produced is used as a fuel. In addition, export projections of ethanol have incredible increased since 2004 due to the high oil prices and the high demand for cheaper fuel in places like China. This situation is already making significant contributions to Brazil's trade surplus; boosting the country's economy and reducing its reliance on foreign oil. It is indeed a great example of how the political will and commitment by Brazil have allowed them to become the biggest producer of a renewable energy.

Brazil is also taking advantage of its technology advances and its massive amount of land for sugarcane and ethanol production. As the largest sugar producer in the world (with output of 26 million tons in 2003) and the largest producer of ethanol (EIU, "Ethanol Producers"), Brazil has great potential to provide fuel supply to the global market. As of now, Brazil's world market share of ethanol is currently close to 40% (a volume of 2.2 billion liters), with sales around US\$ 3 billion in 2004. Many countries in the world are looking for cleaner burning fuels. Japan for instance, has introduced fuel blend with a 5% ethanol²⁷. Russian on the other hand has agreed to sign the Kyoto protocol, which commits countries to limit its local emission levels. Brazil has indeed the resources at a low cost to satisfy this ethanol demand in the world.

Other investment opportunities and new automobile technology are making ethanol attractive for different companies. Companies such as Crystalsev, a major sugar and ethanol producer in Brazil is betting on the high demand of ethanol in Brazil and the rest of the world. For instance, Crystalsev has invested in El Salvador by building a distillery with a capacity of

²⁶ 20% of Brazil's total transport fuel market (Luhnow and Samor)

²⁷ Brazil currently mandates a 20% blend of ethanol with gasoline.

200 million liters a year to take advantage of trade agreements such as CAFTA-DR and obtain market access in the United States. Eduardo Pereira de Carvalho, president of the São Paulo Sugarcane Agroindustry Union (UNICA) estimates that demand of ethanol in the United States will rise to 10 billion liters by 2010 (“Caribe Atrai”). This will present great opportunities for the industry.

The automobile industry is also making impressive advances in Brazil by taking advantages of the ethanol production. In contrast to the early hydrous-powered vehicles in the 1980s; the automobile industry has invested in *flex-fuel* technology. This technology is able to make cars run on either pure hydrous ethanol or gasoline blended with anhydrous ethanol. Fernando Damasceno, chief engineer at the Brazilian unit of Italian car parts company Magneti Marelli, created a device able to calculate the mixture of ethanol versus gasoline in the tank and adjust the engine accordingly (Luhnow and Samor). This device was sold to Volkswagen in 2002, which later introduced its first *flex-fuel* Gol. Five major car makers in Brazil are now producing *flex fuel* cars²⁸. In 2004, the first full year of *flex-fuel* cars out in the market, accounted for more than 17% of the Brazilian market. Indeed, ethanol has become a major industry in the Brazilian economy and the government has played a very important role for its current success.

Summary

With the arrival of the first oil shock in 1973, Brazil was forced to look for policies able to reduce its dependence of oil. By 1974, Brazil imported about 80% of its fuel and about 40% of its foreign-exchange income was used for oil import bills (Luhnow and Samor). As a result of

²⁸ Ford Brazil has just introduced a small *flex-fuel* SUV called Ecosport

the challenges faced by Brazil, General Ernesto Geisel opted for an expansionist policy in order to keep the economy from a recession and in November 1975 the PNA was created.

From the start of this program, the government played an important role as it implemented different government tools to support the PNA. However, Brazil went through difficult economic transitions and new economic policies which put the ethanol program throughout a variety of stages. Since the 1970s, Brazil experienced two oils shocks, a period during the 1980s known as the “Lost Decade”, economic reforms during the 1990s, and a financial crisis in 1998. Today Brazil positioned itself as one of the most important economies in Latin America, as well as a leader in the world economy. The ethanol program has been a part of this Brazilian experience during the last three decades through the different mechanism the government have implemented at times for the development of the program. Today, ethanol not only have helped Brazil to reduce oil imports, but it is estimated that the country have saved about US\$ 69 billion that would have been use to buy oil from areas like the Middle East (Lashinsky and Schwartz). Currently, ethanol is looked upon developed and developing countries as an alternative fuel that will alleviate the world’s addiction of oil and will create benefits for the environment. Ethanol demand has dramatically increased and Brazil is making the investments necessary to meet global demand. Even countries like India and China have sent top officials to Brazil to gather more information about the ethanol program. India, which is the world’s second biggest sugar producer after Brazil, mandated in 2003 that nine of its states add a five percent ethanol mix to gas (Luhnnow and Samor). Other countries such as Japan have done similar policies. In the United States, even though ethanol currently has an import tariff of US\$ 0.54 cents per gallon from Brazil, some politicians as well as the Brazilian government have been lobbying to remove

the tariff in order to create an ethanol global market and to create more competition in the U.S. to speed up ethanol production by local producers.

Although government involvement with the ethanol program in Brazil has been reduced since 1997, the role of the Brazilian government in the past cannot be disregarded. Since 1975, the goal of this program has been to become what it is today. The idea that ethanol is now a legitimate alternative fuel or that 7 out of 10 new cars sold in Brazil are *flex-fuel*, is indeed an accomplishment that the supporters of the ethanol program and Brazilian government officials had in mind. The following chapter covers the different government policies such as price policies, tax incentives, and financing programs implemented in Brazil to encourage the production and consumption of sugarcane based ethanol as an alternative fuel.

Table 2-1. Brazilian Balance of Payments (US\$ millions) (1970 – 1980)

Year	Exports	Imports	Trade Balance	Current Account
1970	2,739.0	2,507.0	232.0	-562.0
1971	2,904.0	3,245.0	-341.0	-1,037.0
1972	3,991.0	4,235.0	-244.0	-1,489.0
1973	6,199.0	6,192.9	7.0	-1,688.0
1974	7,951.0	12,641.3	-4,690.3	-7,122.4
1975	8,669.9	12,210.3	-3,540.3	-6,700.2
1976	10,128.3	12,383.0	-2,254.7	-6,017.1
1977	12,120.1	12,023.0	97.10	-4,037.3
1978	12,658.9	13,683.1	-1,024.1	-6,990.4
1979	15,244.4	18,083.1	-2,838.7	-10,741.6
1980	20,133.9	22,954.0	-2,821.00	-12,807.0

Source: Werner Baer, 2001

Table 2-2. Economic Indicators (1974 – 1982)

Year	Real GNP Growth (%)	Gross Foreign Debt (US\$ million)	Balance of Payments (US\$ million)	Oil Imports (US\$ million)	Oil Imports as % of Exports
1974	9.8	17,166	-4,690	2,969	35.3
1975	5.7	21,171	-3,540	3,100	32.7
1976	9.0	25,985	-2,255	3,842	35.0
1977	4.7	32,037	97	4,080	31.5
1978	6.0	43,511	-1,024	4,483	33.0
1979	6.4	49,904	-2,840	6,773	42.0
1980	8.0	53,847	-2,829	9,800	47.2
1981	4.5	61,410	-500	10,600	45.5
1982	0	69,650	780	9,570	47.4

Source: Armand Pereira, 1986

Table 2-3. Sales of Conventional and Hydrous-Ethanol Cars (1974 – 1983)

Year	Total Car Sales (thousand)	Sales of Hydrous Ethanol Cars (thousand)	Share of Hydrous Ethanol Cars (%)
1974	854.2	0	0
1975	931.5	0	0
1976	974.6	0	0
1977	908.6	0	0
1978	1067.3	0	0
1979	1121.2	0	0
1980	1010.6	240.7	24
1981	635.1	137.2	22
1982	691.3	235.1	34
1983	730.5	585.2	80

Source: Armand Pereira, 1986

Table 2-4. Production of Ethanol Powered Cars in Brazil (as a Percentage of New Cars Produced)

Years	Production (Number of Cars)	Percentage of New Cars Produced
1979	3,328	0.4
1980	239,251	25.6
1981	120,934	20.6
1982	214,406	31.9
1983	549,550	73.4
1984	496,653	73.1
1985	573,383	75.5
1986	619,854	76.0
1987	388,321	56.8
1988	492,967	63.0
1989	345,605	47.3
1990	71,523	10.8
1991	128,857	18.3
1992	163,127	20.0
1993	227,684	20.7
1994	120,177	9.6
1995	32,628	2.5
1996	7,200	0.6

Source: Anfavea 1996

Table 2-5. Brazilian Ethanol Production (1995/1996)

<p>13.1 billion liters of ethanol were produced from 62% of the cane crop:</p> <ul style="list-style-type: none">- 67% was produced at 170 annexed distilleries (associated with sugar mills)- 33% was produced at 140 distilleries not associated with sugar mills- 3.5 billion liters were anhydrous ethanol- 9.6 billion liters were hydrous ethanol <p>85.5% of the ethanol produced came from the centre-south region of Brazil:</p> <ul style="list-style-type: none">- 7.9 billion liters were produced at annexed ethanol distilleries- 3.3 billion liters were produced at distilleries not associated with sugar mills <p>14.5% of the ethanol produced came from the north-northeast region of Brazil:</p> <ul style="list-style-type: none">- 0.9 billion liters were produced at annexed ethanol distilleries- 1.0 billion liters were produced at distilleries not associated with sugar mills <p>1.8 billion liters were imported to meet national demand</p>

Source: Ogenis Brilhante, 1997

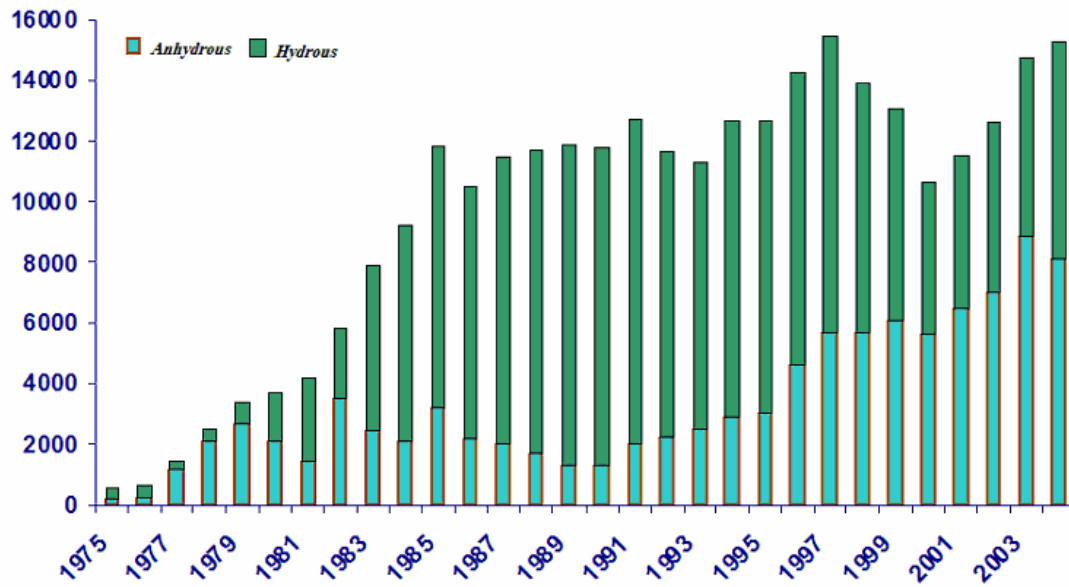


Figure 2-1. Brazilian Ethanol Production (1975 – 2004) (million of liters). Source: Plinio Mario Nastari, 2004

CHAPTER 3 POLICY INSTRUMENTS

Policy instruments are essential tools used to promote different government initiatives. In countries like Brazil and the United States, policies can be implemented by the federal, state, or local government. Policies are a plan of action that governments employ to pursue the population or businesses to follow mandates to obtain results such as higher revenues through fiscal policies or to control aspects of an economy through regulatory policies.

Policy instruments are vital to promote alternative fuel use. The government has in different policy options that can be used to establish rules to develop new technologies. However, these mandates or regulations need to be well designed in order to attract both the population and the private industry to an alternative fuel program. Government officials can create policies to impact both the supply-side and demand-side of an industry. In the case of ethanol, if incentives are created for producers to make fuel, but the car industry does not produce cars able to run with ethanol, then the program would result in a failure. At the same time, if policies are targeted to make consumers and car companies use new technology, but both ethanol producers and distributors do not deliver the fuel, the program will not be able to take off. In the end, government policies to promote ethanol as an alternative fuel source need to encompass all important players of the economy in order to create a market for the fuel. The policies must target both the demand and supply side, with financial and non-financial incentives to make the program a success.

This chapter focuses on the policies available for a government when promoting alternative fuel programs. Since there are a variety of policy tools available for governments, it is important to understand the most effective policies available. In addition, this chapter discusses the policies implemented by the Brazilian government over the last thirty years of the PNA.

Government Policy Options

Different policy options are available for governments to regulate or to promote alternative fuel programs. When designing policies, three target groups need to be taken into account: producers to create improvements in the technology, consumers in order to change their behavior towards alternative fuels, and distributors in order to make the fuel available. All policy instruments and incentives designed by the government need to affect both the demand and supply side of the industry by affecting these three players. This would result in the creation of a market for the alternative fuel.

Two of the main tools available are regulatory and fiscal policies. According to Winston and Crandall, regulatory policies control the entry conditions in a given market (Crandall and Winston 5). Another definition, according to L.R. Jones, is that regulatory policies are an imposition by governments of rules intended to modify the behavior of individuals, groups, units of government, and the private sector (Jones 328). On the other hand, fiscal policies according to David Weil are "... the use of the government budget to affect an economy" (Weil). For example, the government engages in fiscal policy when it collects taxes to purchase goods and services.

Supply side policies or those policies oriented towards producers and distributors include technology development programs, fiscal measures such as tax breaks, subsidies to cover production costs, and regulatory policies such as environmental regulations. Consumers are also a vital part for the success. The government needs to create policies that can increase the demand side for the alternative fuel. For instance, in order to control the demand for conventional fuel and promote alternative fuels, the state can create fiscal incentives for consumers when buying the new fuel or when buying manufactured goods with higher energy

performance standards. The results of consumer oriented policies can increase demand for new fuels, new energy-efficient goods, and create a successful market for new technologies.

Producer and Distributor Oriented Policies

Regulatory policies are tools used to mandate private industries to produce more energy-efficient goods or new alternative fuels. These policies can be in various forms including constitutional amendments, decrees, statutes, executive orders, legislative resolutions, publicly approved initiatives, and other forms. The idea behind regulatory policies is to control businesses and to change their behavior in the private sector (Jones 329). However, in a market economy, regulations should be imposed by the state to monitor the economy and not to control it. An authoritarian imposition of new regulations can result in a reduction of foreign investment that can eventually hurt the economy.

Environmental regulations are a tool created to handle and control industrial waste and other emissions for environmental purposes. These are regulatory policies that can be designed to make producers use new sources of fuels. For instance, gasoline-powered cars still remain the largest source of air pollution due to the continue increase of its production (Brilhante 439). The rapid increase in the number of cars, especially in large metropolitan areas, has created severe issues regarding air quality. Governments are able to make legislations aimed at the reduction of air pollution by implementing regulations to make cars more fuel efficient or power engines with alternative fuels such as natural gas or ethanol. As a result, environmental regulations serve as an important tool capable of controlling industrial waste pushing companies to developed more energy-efficient technology for the future.

Producer and distributor oriented fiscal policies are also necessary to impact the supply side of the industry. These can include government financing for production, subsidies to reduce production costs, tax benefits, or government spending towards infrastructure. In alternative fuel

programs, high start-up costs to produce new technologies can be a disincentive for many businesses. Governments get involved in the development of ethanol by providing low interest rate loans or subsidies for projects involving construction of distilleries or purchase of raw materials. Since vehicles able to operate with alternative fuels are also vital for the success of an alternative fuel program, companies can use tax benefits to engage in research on production of new car technologies.

By investing in infrastructure and alternative fuel programs in a responsible manner, the government employs fiscal policy to send positive signals to consumers and other private investors. Therefore, when analyzing the development of alternative fuel programs, heavy investment capital needs to be available to produce new technologies and to create a reliable distribution system. In order to help companies and distributors achieve these goals, governments can opt to give subsidies to cover production costs. These expansionary fiscal tools by the government can be of great benefit for companies to cover their start-up costs and adapt the infrastructure in pump stations for new alternative fuels.

Consumer-Oriented Policies

Consumer oriented policies are also necessary to develop an alternative fuel program. For instance, initiatives towards improving mass transportation in major cities or creating regulatory transit laws to increase activities such as carpooling can be put in place to promote conservation of energy. This type of policies can change people's commuting behavior. However, regulatory and fiscal policies are vital to reduce people's energy bills and to impact consumer's behavior towards alternative fuels. There is not one policy that can be adopted to solve these energy challenges. A mix of policies combined with financial and non-financial incentives are needed in order to promote alternative fuels.

Price controls can serve as a regulatory policy intended to increase consumer demand of new fuels. By establishing or guaranteeing lower prices compared to conventional gasoline prices, the government would directly affect the market by creating a more economical option for consumers. This is indeed a regulation that may have a high price tag for the government or fuel companies if the fuel has to be subsidized, but in current times where oil has reached over US\$ 60 a barrel, increase in the demand for alternative fuels can be seen without engaging in price controls.

Fiscal policies can also form part of a mix of policies oriented towards consumers. According to Robert Crandall, there are fiscal policies that directly affect automobile ownership such as higher gasoline taxes that are more effective than those designed to shift people to energy-efficient alternatives (Crandall 20). A gasoline tax is an indirect duty that is collected from citizens by vendors selling or distributing the fuel (Denison and Eger 165). If a gasoline tax is increased, which would result in higher prices of gasoline, consumers will tend to look for cheaper alternatives. With this in mind, fiscal policies such as higher taxes on gasoline can be an instrument that governments can implement to change consumer behavior to increase demand for new fuels.

Fiscal policies allow the government to make decisions such as tax cuts in order to raise disposable income for the population. One way to implement efficient fiscal policies is for the government to set lower tax rates for alternative fuels in order to make consumers switch. This can also be applied towards manufactured goods such as cars. Lower tax rates to purchase *flex-fuel* vehicles for example will make consumers be more inclined to buy them.

When promoting alternative fuel programs, consumer and producer oriented policies can be of great advantage for the government. New rules can be set by the federal, state, or local

government in order to push companies to invest in new technologies and change the behavior of the population to start consuming other energy sources. All these policies can benefit alternative fuel programs by increasing the use of more energy-efficient technologies, rising fuel efficiency standards on manufactured goods, regulating greenhouse emissions to protect the environment, and increasing the demand of new fuels to create an efficient market.

Brazilian Ethanol Policies

When the PNA was created in 1975, the Brazilian government had enough power to put in practice a set of policies designed to promote the program. Brazil's government in the 1970s and 1980s was a military government and central player in the nation's economy. It had various policy tools and powers at its disposal which brought both intended and unintended consequences to the country. In order to maintain high levels of economic growth rates after the first oil shock in 1973, the government's main priority was to guarantee the energy supply in order to prevent a slow down in energy consumption. As a result, the government opted to create an alternative fuel program providing financial support and financial incentives for its development. Financial incentives were the main tools available for the building of distilleries to produce ethanol even though production costs for ethanol were higher than for gasoline.

Brazil intensified ethanol development program after the second oil shock in 1979. With new policies, the goal of the PNA was to reduce the country's reliance on foreign energy sources by increasing domestic energy production, of which ethanol was a key component. The result was the creation of a more broad mix of policies and mandates intended for both producers and consumers to increase ethanol production and consumption. The efforts and policies implemented after the second oil shock reinforced the importance of the ethanol program for Brazilians. Regulatory agencies, fiscal, and regulatory policies were created to support the program throughout its development phase. These policies included various financial and non-

financial incentives that allowed producers and consumers to buy into the new technology. The idea behind the government's support was to increase supply and use of ethanol by reducing production costs and making the price lower than conventional gasoline.

Towards the end of the 1990s, Brazil faced new economic challenges that brought new changes to the PNA. By 1997, the government support that allowed the ethanol industry to develop was mostly eliminated. Producers had to adapt to these changes and the government took another role for the industry. The policy evolution in Brazil towards the ethanol program over the last three decades has created different results. However, it is important to notice that all the players of this industry have been able to adapt to changes and today the industry experiences great success.

Government Agencies

When the second oil shock occurred in 1979, the Brazilian government decided to enlarge the PNA by providing more support to ethanol producers and creating government agencies to manage the program. Two state-run agencies played vital roles in implementing the PNA: The Institute of Sugar and Alcohol (IAA) and Petrobras.

The IAA's role as a state enterprise was to control the production of sugar and ethanol through production quotas or by purchasing programs. In 1979, the IAA purchased anhydrous ethanol at an equivalency rate of 44 liters of alcohol per 60 kilogram bag of sugar (Buzzanell et al. 127). Also, the IAA administered loans at low fixed interest rates for projects involving the construction of distilleries and autonomous ethanol plants.

In 1979, the Brazilian government of General João Baptista Figueiredo ordered the state-run oil company Petrobras to make ethanol available at all its filling stations. Petrobras also had the main responsibility of guaranteeing the supply of ethanol around the country. The distribution of ethanol through Petrobras was important in building the confidence of Brazilian

consumers. The government needed to make sure that ethanol was available at filling stations all over the country in order to promote this fuel alternative. This mandate by the military government showed to consumers the importance of ethanol for Brazil's future. This type of policy would be more difficult to pursue in countries like the United States, where the executive would need support by other branches of the government and distribution of fuel is through private companies.

The policies implemented through these two agencies guaranteed higher prices for sugar and other crops used in ethanol production compared to other agriculture crops (Brilhante 438). In a way, everyone involved in the production of ethanol was assured a profit from their investments. In addition, since ethanol prices were set by the government to be lower than gasoline, consumers bought ethanol to avoid the high cost of gasoline. These agencies were responsible for the growth of ethanol production post 1979 (Appendix B).

Regulatory Policies

Brazil has used regulatory policies to shape the ethanol program by making private companies follow rules in order to create a market for ethanol. In addition, through these regulatory policies more cooperation among the government, the sugar and car industry was created to establish ethanol as a reliable fuel. All these groups were committed to the ethanol program by following the regulations and using the government incentives. Throughout the last three decades, Brazil has adopted four important regulatory policies for the promotion and development of ethanol as a fuel: blend ratios with gasoline, price policies, production quotas, and environmental regulations.

Blend ratios

The blend ratio determines the mix between anhydrous ethanol and conventional gasoline in order to produce gasohol. Since the beginning of the PNA, anhydrous ethanol was produced

to be mixed with conventional gasoline. In 1975, President Ernesto Geisel ordered that the country's gasoline supply be mixed with 10% ethanol (Luhnow and Samor). Today, this ratio is set by the Ministry of Agriculture, Livestock, and Food Supply (MAPA) every year in order to balance the relationship between the supply and demand of sugar and ethanol (Koizumi). These ratios depend on the price of sugar, demand for ethanol, and the price of oil in the international markets (Buzzanell et al. 129). In May 2001, the Brazilian government increased the blend ratio from the 2000 level of 20% to 22% due to the increase in ethanol production. Then in January 2002, the government raised it again to 24%. As of January 2006, the ratio was lowered to 20% anhydrous ethanol because of the higher demand of ethanol and the increase of international price of sugar.

The relationship of sugar and oil prices, as well as the demand for ethanol, is vital for determining how the government sets blend ratios. Since 1997, the blend ratio has been the one tool implemented by the government to control ethanol production in Brazil. For instance, in early 2006 the blend ratio was lowered from 25% to 20% ethanol. There were various issues that influenced the government's decision. The most important one was the fact that raw sugar prices reached a 25 year high in January 2006. According to the New York Board of Trade, raw sugar climbed to 17.15 cents (US\$) a pound which was the highest market close since 1981 (Dawn). A major influence in the increase in the price of raw sugar has been Brazil's increasing use of sugarcane as raw material to produce ethanol. Therefore, Brazilian producers have been inclined to sell raw sugar at the international market for sugar production. At the same time, demand for ethanol is still soaring due to the high oil prices. In order to assured a reliable supply of ethanol for the domestic market, the Brazilian government needed to reduce the blend ratio for this year (Table 3-1). The blend ratio has created an important domestic ethanol market in Brazil.

Although ethanol prices have been deregulated since 1997, this regulatory policy instrument remains in place to allow the government to still influence the magnitude of demand for ethanol and thus guarantee the market for ethanol producers.

Price policy

Under the National Alcohol Council's guidelines, the IAA established the price of both sugarcane and ethanol. All the ethanol and sugar that was produced in Brazil was purchased by the government at prices above cost²⁹. Using public funds, the government paid producers at prices that varied according to the type and usage, and they were set at parity with sugar prices. In 1981, ethanol was set at an average of 38 liters per 60 kilogram bag of sugar (Pereira 51).

The price of hydrous ethanol at the pump was also managed by the Brazilian government to guarantee lower prices to the consumers. The policy set hydrous ethanol at 60% to 65% that of gasoline or gasohol. These prices were the same throughout the country, making it accessible for every Brazilian. In 1989, a gallon of hydrous ethanol cost US\$ 1.27 per gallon compared with US\$ 1.70 per gallon of gasoline (Kandell). As a result, the price policy implemented by the military government in 1979 gave it the flexibility to increase or decrease consumer prices of gasohol and hydrous ethanol when necessary. This policy worked as a very important incentive for ethanol producers as well as consumers and assured profits for all those producers linked to the industry and savings for those who consumed it. This policy tool was indeed a driver for the ethanol success.

Production quotas

The production quotas stipulated by the IAA under the National Alcohol Council in 1979 was a policy that allowed the government to control the supply of sugar and ethanol for domestic

²⁹ Prices were readjusted every six months (Pereira 51)

and foreign demands. The IAA had the responsibility to determine the quotas for sugar and ethanol production for each sugar mill and distillery. These quotas were set depending on the international demand for sugar and the International Sugar Agreement (ISA). Sugar and ethanol producers were not allowed to exceed their quotas under any circumstances unless it was authorized by the IAA or international sugar prices increased beyond the ISA requirements (Pereira 52).

Deregulation of sugar and ethanol production in 1997 brought the end to production quotas. Today through regulatory policies such as blend ratios and environmental regulations, the Brazilian government acts as a regulator to many aspects of the economy. The end of production quotas and government control of the sugar and ethanol industry exposed all producers in a market economy. This situation forced producers to become more efficient by reducing costs without the control or support of the Brazilian government.

Environmental policies

Brazil suffers from pollution, especially in its large urban cities. São Paulo, for example, has severe air quality problems due to the number of vehicles circulating as well as the high number of industries concentrated in its surroundings. During the late 1970s and throughout the 1980s, Brazil has tried to improve its cities' air quality by introducing regulations such as emission control devices in vehicles manufactured in Brazil and implementing the distribution of anhydrous and hydrous ethanol. These environmental policies were designed to alleviate the pollution by promoting clean renewable sources such as ethanol.

Today other environmental challenges have affected Brazil. One of them is the pollution that has taken place from the ethanol production. Burning of sugarcane fields is conducted before harvesting to eliminate pests and remove weeds. However, the burning has created high quantities of greenhouse gases, ash, and other airborne particulates that have affected air

qualities not only in urban areas but also in rural areas. As a result, some regulations at different levels of the government have been created to deal with this problem. One regulation implemented in September 2002 was the law 11.241/02 of the State of São Paulo. This law was designed to change burning techniques in areas suitable for the replacement of manual harvest with mechanical harvest. It required that the burning of sugarcane be reduced to 20% of the harvested area in 2002, to 30% by the fifth year, 50% by 2011, 80% by 2016, and 100% of the harvested area by 2021 (Martines-Filho et al.). There are some exceptions to the law in which areas with a slope of 12% or more were allowed burning in grounds because mechanized harvesting would have been impossible (Martines-Filho et al.). This situation became an unintended result from the implementation of different regulatory policies to promote ethanol production.

Another regulation implemented and approved by the Federal Government requires investors to obtain licenses to install and operate sugar mills. This ability allows the government to choose the locations of the sugar mills. Hence, the federal government has given licenses to companies to develop sugar mills in rural areas in the north of the country to create new sources of employment and alleviate the environmental issues in industrial states such as São Paulo. These policies have been of benefit for the government to manage environmental issues and provide jobs in rural areas especially in the north. However, much more still needs to be done since Brazil still has a long way to go to control the various environmental challenges. As the country continues to expand the ethanol industry, more policies should be implemented by legislators in order to deal with these challenges.

Fiscal Policies

Fiscal policies have being a vital instrument for the Brazilian government throughout the history of the ethanol program. The different incentives provided by the state allowed sugar

producers and automobile companies to produce ethanol fuel and ethanol-powered vehicles in an era of high and low oil prices. Financing policies such as low interest loans for the construction of distilleries, tax breaks for the purchase of ethanol-powered vehicles, or lower tax rates for hydrous or anhydrous ethanol were the most significant tools that helped both producers and consumers to turn to ethanol.

Financing policy

The financing that the Brazilian government provided to producers also helped the ethanol industry. This policy instrument was vital in the early stages of the PNA for producers since it financed new distilleries and sugarcane cultivation. However, it is important to point out that these loans were given in a time where the Brazilian economy experienced high inflation rates. Funds for the ethanol program consisted of low interest loans for investment at negative real interest rates due to high inflation rates. The life of these loans was usually 15 years with 3 years of grace period. With high levels of public debt and the elimination of foreign borrowing after 1982, the Brazilian government financed much of its deficit by printing money. Inflation rates years prior to the first oil shock were below 20%. By the end of 1985 inflation went up to almost 250% (Durevall 423). This chronic inflation³⁰ continued throughout the 1980s; reaching a record of 366% in 1987 (“New Brazil”).

From the beginning of the PNA until 1981, loans given by the government covered up to 80% of industrial investments in sugarcane distilleries. The nominal interest rates on these loans varied from 2% to 6%³¹ (Pereira 52). Loans given for agriculture investments associated with

³⁰ Dick Durevall explains that high and persistent inflation of the kind experienced by Brazil in the 1980s is labeled chronic inflation (Durevall 423).

³¹ The interest rates of the loans depended on the type of distillery and location. The rates also had partial adjustment for inflation.

ethanol projects covered 60 to 100% of the total, at nominal interest rates between 15% and 29% depending on the farm size and it was not adjusted for inflation (Pereira 52).

After 1981 the government made changes to this policy. Due to the increasing inflation during the early 1980s, the interest rates were raised but they were still negative in real terms. In 1982, the nominal interest rates were raised between 45% to 55% depending on its location (Pereira 52). Loans for industrial investments covered up to 70% to 80% depending on the type of distillery and up to 90% if owned by cooperatives. Loans for agricultural investments related to ethanol production continued to cover 60% to 100% with nominal interest rates of 35% to 45% depending on the location of the projects (Pereira 52). The increase of interest rates on these loans did not affect producers due to the high rates of inflation. These subsidized government loans allowed investors to obtain the capital needed for the building of sugar mills that today are still producing important amounts of ethanol. Although the government was losing money on the loans, the policy turned to be of great benefit for investors and the ethanol program. This financing policy brought positive results to the PNA even though back in the 1980s was hard to justify.

Ethanol vehicles taxation

Taxation is one of the most effective fiscal policies available for the government. Both companies and consumers can take advantage of the disposable income created from tax breaks in order to produce or consume new technologies. Brazil has utilized vehicle taxation policies since 1979 to make ethanol vehicles more attractive. Car companies in 1979 were given tax breaks for just having ethanol powered vehicles in their showrooms. Consumers were also given tax benefits as a fiscal incentive when purchasing these cars. In 1979 the Italian auto maker Fiat offered its first ethanol fueled car (Luhnow and Samor). Then in 1980, every domestic and

foreign car company produced and sold ethanol powered cars to the Brazilian market. By 1983, nine out of every 10 new cars sold in Brazil ran on pure ethanol fuel (Plummer).

The tax incentives have helped ethanol become such of important alternative fuel. Both producers and consumers have taken advantage of these tax brakes in order to produce and obtain the fuel and vehicles at lower prices in a time where oil prices have continued to increase. Throughout the history of the PNA, this policy instrument has allowed producers to make the necessary investments in the technology. Moreover, consumers have also been able to make the transition to ethanol with these tax breaks to the point that ethanol now accounts for more than 40% of the fuel Brazilians consume (Lashinsky and Schwartz).

Today Brazil produces three different types of car engines or internal combustion engines³². There are the ones that are fueled with conventional gasoline, hydrous ethanol, and *flex-fuel*³³ vehicles. Hydrous ethanol powered cars or *flex-fuel* cars are given an IPI³⁴ tax incentive. According to the Brazilian tax structure, depending on the size of the engine, a regular or reduced tax rate is imposed (Table 3-2).

The success of the ethanol program can also be attributed to the incentives provided by the tax breaks given to ethanol and *flex-fuel* vehicles. Since 2003 ethanol sales have increased dramatically after the introduction of *flex-fuel* vehicles. These cars are able to gauge the ethanol and gasoline ratio on the tank and adjust fuel injection and cylinder compression automatically (Barros and Perkins 2). This arrangement allows the consumer to buy gasoline at any blend ratio

³² The Italian car manufacture Fiat has also introduced a model named the Siena Tetra Fuel. This car can run on 100% hydrous ethanol, gasohol, conventional gasoline, or natural gas.

³³ These cars were introduced in March 2003. Consumers can choose the cheapest fuel available since the cars can be fueled with conventional gasoline, hydrous ethanol, or gasohol (mix of anhydrous ethanol and conventional gasoline).

³⁴ The IPI is a federal tax imposed to industrialized goods

or pure ethanol depending on the relative price, without hampering the performance of the car. The efficient tax policies towards these vehicles have made these cars more than popular. The policy was aimed at both the supply-side and demand-side in order to create a successful market for the fuel. Today, not only the cars receive favorable tax treatment, but consumers can also obtain the fuel at favorable tax rates at virtually all gas stations in the country thanks to the well established distribution center and infrastructure to handle ethanol.

Fuel taxation

Fuel taxation is a policy that the Brazilian government has used to directly affect drivers. Since much of the fuel taxes are reflected on the price of the fuel, this policy has indeed created incentives that have made ethanol fuel more attractive. The federal and state taxes imposed to fuels differ for gasoline and ethanol. Currently, these differential taxes act to support the demand for ethanol at the expense of gasoline. In Brazil, there are four different taxes applied to fuels; three federal taxes and one state tax that varies in every state:

- CIDE: Federal tax (used to finance infrastructure works and maintenance of transportation systems)
- COFINS: Federal tax for social security programs
- PIS: Federal tax for social development programs
- ICMS: State tax applied on goods and services (varies between 12% to 31%) (Table 3-3)

Since its price started to be determined by the market in 1997, the favorable tax treatment for ethanol at the filling pumps is the biggest incentives for consumers. The Brazilian government imposes higher rates for gasoline than for ethanol under its CIDES, PIS, and COFINS programs. The difference between gasoline and ethanol taxes was estimated at

approximately 0.30 reals³⁵ per liter in October 2005 (Barros and Perkins 3). Moreover, each state has the right to assess tax brakes for the use of ethanol under its ICMS tax program. In São Paulo for example, ethanol had a tax advantage of approximately 0.50 reals per liter compared to gasoline in October 2005³⁶.

This policy together with the current increase in gas prices, has created a significant rise in the demand for ethanol in the last six years (Barros and Perkins 3). It has become more effective than any other policy implemented since it directly affects automobile ownership. The consumers are the group that untimely needs to buy the fuel in order to make alternative fuel programs successful. In Brazil, the fuel taxation policy has been one of the most effective tools because it has changed the behavior of consumers towards buying ethanol as their fuel source.

Other important fiscal tools

Funding for research was also among the mix of fiscal policies created by the Brazilian government. The government's spending towards ethanol was part of the expansionary policy taken since the creation of the PNA. According to the Wall Street Journal, the Brazilian government funded Urbano Ernesto Stumpf, a researcher at the Brazilian Air Force Laboratory who concentrated on the development of a car that would run only on ethanol (Luhnow and Samor). Mr. Stumpf developed three ethanol powered cars that in November 1976 embarked on a 5,000 mile trip from the air force's research lab in the southeastern state of São Paulo to Manaus. The funding for research by the government allowed for the investigation of more efficient vehicles powered with ethanol in Brazil. Today, *flex-fuel* vehicles are the latest result of the research done throughout the last three decades in Brazil.

³⁵ According to the latest indicators from EIU Viewswire, the average exchange rate of Real/Dollar in the 4th quarter of 2005 was 2.25.

³⁶ Prices at filling pumps for ethanol were 1.14 reals per liter and 2.22 reals per liter of gasoline in October 2005 (Barros and Perkins 3).

The “New” PNA

The first ethanol-only vehicles were tough to start on cold mornings. Sugar mills responded to high world sugar prices in the late 1980s by producing more sugar and less ethanol, resulting in fuel shortages that left drivers fuming and seriously dented the program’s reputation for reliability (Lynch).

High inflation, ethanol producers’ debt, changes in the political environment with the civilian government in 1985, and cuts in funding for the PNA hurt the credibility of the ethanol program in Brazil. At the beginning of the 1980s, Brazil faced several macroeconomic issues that put the country’s economy in a vulnerable position. After the Mexican debt crisis in 1982, Brazil was unable to finance its current-account deficit through external borrowing. The crisis dried up the sources of financing and the PNA started to see cuts on its funding. In addition, other factors affected the ethanol program. Oil prices fell from their 1970s highs, international sugar prices increased, and Petrobras discovered new offshore oilfields which made Brazil more self sufficient in oil. These factors all together made it costly for the government to continued supporting the ethanol and sugar industry.

The program went from a stage of overproduction to deficit. In 1990, the government was forced to import ethanol for the first time to meet national demand (Brilhante 439). This situation affected the distribution of ethanol in several areas of the country and consumers had difficulties finding ethanol. The production of ethanol powered cars in 1990 declined from 47.3% of new cars produced to only 10.8% (Table 2-4). Indeed, the macroeconomic and political problems of the 1980s and early 1990s in Brazil brought a sense of failure for the PNA. In 1987, an energy economist from the University of São Paulo criticized the government for wanting to keep the ethanol program: “There is no plausible economic explanation for the alcohol program” (Kandell)

The role and support of the government drastically declined during the 1990s as the country ran into more budget deficits and it continued to experienced high inflation rates. Then in 1994 oil prices dropped to its lowest level since 1973 (Williams). This situation created ethanol shortages throughout the country. In 1995, the Brazilian ethanol production did not meet national demand. In that same year, 13.1 billion liters were produced and 1.8 billion liters of ethanol were imported (Table 2-5). As a way to respond to these challenges, many distilleries in the 1990s started to incorporate sugar mills into their existing installations (Brilhante 439). This began a new phase for the ethanol industry in the 1990s. Ethanol producers needed to become more efficient since government support was significantly reduced. Datagro, a Brazilian consulting firm, estimated that the government spent at least US\$ 16 billion in 2005 dollars³⁷ from 1979 to the mid 1990s (Luhnnow and Samor). This total included loans to sugar companies, ethanol plants, and the price support system for the fuel.

With the growing problems the government was facing during the 1990s to support the PNA, it was time to make changes. During the period of 1997 to 1999, the Brazilian government made radical reforms towards the ethanol program. In 1997 for instance, the price of hydrous ethanol was decontrolled. Then in February 1st, 1999, anhydrous ethanol was also decontrolled and the mandate given to Petrobras in the distribution and sell of the fuel was eliminated. Moreover, subsidies to ethanol producers were reduced significantly. According to the U.S. Department of Agriculture's estimates, subsidies paid to hydrous ethanol producers were reduced from 0.98 reals per liter to 0.45 reals per liter (Buzzanell et al. 129). Subsidies paid to anhydrous producers were eliminated in 1999.

³⁷ The estimate does not include the foregone revenue from tax breaks as well as other consumer cost.

The government's role changed from instigator to a market supervisor. Currently, there are no restrictions on ethanol production and exports, but the government still sets the blend ratio of anhydrous ethanol to gasoline every year. The "new" PNA left behind much of its policies to turn into a program based on free market economics. As a sugarcane powerhouse, the Brazilian government finally let its industry develop into an even more efficient one by deregulating its production. Even though this deregulation was forced by various economic factors, it greatly reduced the role of the government of the central planner of the PNA. At the end, free market policies towards the ethanol program have allowed it to become an even more important model for the rest of the world.

Policy Outcomes

Ethanol as a fuel alternative in Brazil is the result of hard work and commitment by both the Brazilian government and the private sector. In the last three decades, the policy instruments used by the government paved a road of success for ethanol. Today, even though other economic factors have made ethanol unreliable at times, Brazilians can feel proud that its country is serving as a leader in terms of energy alternatives.

By 1984, the government's policies implemented in 1979 boosted the ethanol production in Brazil. The outcome of these early policies was an increase in the ethanol production from 0.6 billion liters in 1976 to 9.2 billion liters in 1984 (Brilhante 438). This increase meant an average annual rate of growth of 40%. Moreover, ethanol reached about 10% of the actual demand for oil products and the consumption of ethanol (both anhydrous and hydrous) reached 6.6 billion liters in 1984 (Brilhante 438).

All the policies implemented throughout the years helped the PNA retain the confidence of Brazilians about ethanol and its future. Due to policies such as lower taxes for consumers, hydrous-ethanol cars for private use became six to seven percent cheaper than gasohol cars and

about 40% cheaper if used as taxis (Pereira 57). Consequently, by 1983 the sale of hydrous-cars increased to an 80% share of total car sales (Pereira 57). Then by 1985 and 1986, more than 75% of all motor vehicles built in Brazil and more than 90% of cars were capable to run on ethanol fuel (Plummer).

Today, Brazil has become an example for the world in terms of alternative fuels. The policies implemented since 1979 have created incredible results for the country: “Brazil’s reliance on oil imports has plummeted from 85% of its energy consumption in 1978 to 10% in 2002” (Oppenheimer). The replacement of oil imports throughout these years have been due to the exploration of new oil fields in Brazil and the fact that ethanol now provides about 40% of the transportation fuel in the country. The reduction of oil imports has been a challenge that the government took upon itself since the 1970s and finally the goals are been reached. Ethanol now serves as one of the most promising fuel alternative available (Friedman). The Brazilian experience is indeed of great help for other countries to pursued alternative fuel program. The following chapter discusses what countries like Argentina and the United State are currently doing to promote alternative energies. Also, the next chapter analysis how the Brazilian experience serves as an example for them to be successful in the implementation of policies that promote alternative fuels.

Table 3-1. Mandated Ethanol Blend Ratios in Brazil (%)

1979	1981	1985	1998	2001	2002	2003	2004	2005	2006
15.0	20.0	22.0	24.0	22.0	24.0	24.0	25.0	25.0	20.0

Source: Brazilian Ministry of Agriculture, Livestock, and Food Supply

Table 3-2. Vehicle Tax Structure (Percentage of Selling Price)

IPI for Ethanol and Flex-Fuel Vehicles	Regular Tax	Reduced Tax
Cars with motors between 1,000 cm ³ and 2,000 cm ³ .	15	11
Cars with motors higher than 2,000 cm ³ .	25	18
Cars with motors lower than 2,000 cm ³ , taxi drivers, passengers transport, cooperatives, and disabled people.	15	0

Source: Brazilian Ministry of Agriculture, Livestock, and Food Supply

Table 3-3. Ethanol and Gasoline Taxation (as of 2004)

Fuel	Taxes	Refinery/Distillery	Fuel Distributor
Gasoline	PIS COFINS CIDE ICMS*	2.7% 12.45% R\$ 0.28/liter	25%
Hydrous Ethanol	PIS COFINS CIDE ICMS*	1.65% 7.60% R\$ 0/liter	1.46% 6.74% 25%**
Anhydrous Ethanol	PIS COFINS CIDE ICMS*	1.65% 7.60% R\$ 0/liter	25%**

* Tax rate depends on the state. 25% is the tax in 21 of 27 states

** São Paulo reduced it to 12% as of January 2006 ("Alckmin")

Source: Brazilian Ministry of Agriculture, Livestock, and Food Supply

CHAPTER 4 ETHANOL LESSONS FROM BRAZIL

In the first part of this chapter, this thesis explains important lessons that can be use as a reference by other countries for future development of alternative fuel programs. The lessons obtained from the Brazilian experience can be of great benefit for those countries interested in promoting biofuels. The second part of this chapter focuses on the energy situation of two countries: Argentina and the United States. This part is essential to understand the current condition other countries in the region are facing with the high price of oil. In addition, as countries around the world start to get more interested in developing a biofuel industry, this section explores what Argentina and the United States are doing in regards to biofuels.

The last section of this chapter compares the policy environment in Argentina and the United States to Brazil and concludes with the end results Brazil has obtained from its ethanol program. Brazil is now a global leader in the production of ethanol. Argentina and the United States are two countries that have started to develop policies designed to promote the production and consumption of the fuel. The Brazilian experience offers valuable lessons for all these countries; some which can follow depending on each of the country's situation or political structure. These comparisons allow the reader to understand the state of biofuels in the region. In the end, the goal of this section is to compare the situation of these two countries with Brazil to identify what other steps Argentina and the United States should take in order to develop a successful alternative fuel program.

There are several countries in the Americas looking into producing alternative fuels such as ethanol. Countries like Paraguay and Peru have recently approved laws designed to promote the production of biofuels (INTA 24). However, the two countries considered in this thesis were Argentina and the United States. In the case of Argentina, this country was considered for

several reasons: first, the country is an agriculture powerhouse capable of producing enough raw materials such as soybeans and corn to meet domestic and international demand of ethanol and biodiesel. Between 2004/2005, Argentina harvested a total of about 84 million tons of grains and oilseeds. Soybeans, corn, and wheat represented 88% of the total 2004/2005 harvest (United States, “Argentina”). This is indeed an advantage that Argentina has over other countries in the region.

A second reason was that Argentina is a neighboring country of Brazil and a member of Mercosur³⁸. As a result, these two countries have already established a political and economic partnership. Through cooperation, these countries can look for ways to develop a bigger and more efficient market for ethanol and other biofuels. Moreover, with the political influence of these countries have, they can design multilateral policies with other members of Mercosur to promote the use of these alternative fuels. One more reason Argentina was chosen was the initiative taken by the Argentine government towards alternative fuels. As of April 2006, the Biofuels Act was approved in Argentina in order to increase the production and consumption of biofuels (“Es ley” 5-2). This is an important step towards creating the necessary structure to develop an industry with potential benefits for the future.

The other country considered in this chapter is the United States. This country was chosen for three important issues: first, since the United States has the highest rate of oil consumption in the world, the current increase in the price of the fuel has put enormous pressure to the country’s economy. This situation is significant due to the importance of the United States’ economy to the rest of the world. Any measures by the government to response to higher fuel costs can have various implications to many countries around the world.

³⁸ A customs union between Brazil, Argentina, Uruguay, Paraguay, and Venezuela.

Today, any event that affects global oil supplies creates more pressure for the U.S. government to react in order to maintain a strong economy. For instance, Hurricane Katrina in 2005, the current war in the Middle East, or the shut down of the oil industry for almost two month in Venezuela³⁹, all have been events that have severely impacted the price of gasoline in the United States. This situation has increased inflation rates in the United States and the Federal Reserve have had to respond with monetary policies such as rising interest rates to control inflation. Therefore, understanding the United States' political and economic decisions to respond oil price fluctuations is of great importance because of the outcome it can have for the country and for the rest of the world.

The second reason why the United States was chosen is that the government has already taken the initiative to look for ways to promote alternative fuels to alleviate the country's addiction of foreign oil. This is the result after all the economic pressures the country has experienced due to the high oil prices. Today, the federal government as well as state governments have started to create policies aimed at the development of a biofuel industry. Therefore, it is necessary to analyze the current policy environment and provide new ideas in order to create a more efficient alternative fuel program. Even though ethanol or other biofuels are not the only solution to reduce all oil imports in the United States, the initiative by the government has started to create awareness among the population about the importance of diversifying the country's fuel sources.

The final reason why the United States was considered is national security. After September 11, 2001, national security became a top priority for the current administration and the population. A reliable oil supply is an important part of national security since this country is

³⁹ The shut down of the Venezuelan oil industry was due to a strike aimed at ousting President Hugo Chavez in early 2003.

heavily dependent on the fuel in order to keep expanding the economy. For that reason, finding ways to reduce foreign oil dependence is crucial for the future of the United States.

Important Lessons from Brazil

In an agroindustrial complex ringed by fields of 12 foot high sugarcane, a giant mechanical claw dumps stalks by the tons into an even larger crushing machine. Here's where the renewable fuel used to power seven of every 10 new Brazilian cars gets its start ("Brazil is").

This is the situation in many towns of the biggest country in Latin America. São Tomé, a southern Brazilian town of about 6,000 people has taken full advantage of the ethanol industry. Not only it provides 92,500 gallons of ethanol to the country daily, but the sugarcane waste is burned to meet all of the distillery's electricity needs and the excess power will soon provide electricity for about half the homes of this town.

Brazil, according to President Lula, is committed to "plant the oil of the future" (Lula da Silva). This is a credible statement coming from a country that throughout the last three decades has been able to nearly reach energy-self sufficiency. In this era of high oil prices, the steps taken by Brazil have indeed attracted many officials from various countries to learn about the Brazilian experience. In countries like the United States, officials from Congress such as Senator Chuck Grassley from Iowa have traveled to Brazil to learn about the public policies pursued by the Brazilian government to achieve its global leadership in ethanol production as an alternative fuel.

The policy instruments implemented by the Brazilian government have delivered positive results for the country. Brazil not only is energy self-sufficient with an ethanol program that can serve as an example for many countries, but the population in towns like São Tomé are benefiting with both jobs and energy. In addition, Brazilian motorists are able to save money and help the environment by having an alternative fuel source capable of replacing oil.

One lesson that governments should take from Brazil is that providing financial and non-financial support to the industry is necessary at its early stages of development. The Brazilian government committed revenues to the ethanol program at its start in 1975. Financial and non-financial support in form of low interest rate loans and production subsidies, or regulations such as fixed ethanol prices, were provided to producers in order to develop the necessary technology to produce and consume the fuel. In the early stages of any alternative energy program, producers need the capital and the time to adapt to the changes and to overcome the transition that consumers go through when switching from one source of energy to another.

Government in different countries must create mandates that can show both producers and consumers the seriousness and commitment of the government towards alternative fuels. Fiscal and regulatory policies are tools that can be of great benefit to promote the fuel and show the government's commitment. Brazil managed to do this by creating policies, such as tax breaks for consumption of ethanol and purchase of ethanol-powered vehicles, as well as imposing blend ratios of conventional gasoline with anhydrous ethanol to control the demand and supply of the fuel. At times, the Brazilian ethanol program went through severe difficulties, such as in the 1990s when funds for financial support were not available. Yet, the Brazilian government showed its commitment to the program by adapting its policies to fit the different economic cycles the country faced. Brazil's experience with ethanol demonstrates that the transition to have alternative fuels as a primary energy source can take years. Therefore, long-term commitments to this type of program by governments send strong signals to consumers and producers about the importance of alternative fuels for the well-being of the economy and the environment.

Many decisions to promote alternative programs can be difficult for politicians; however, determination by members of a government would lead to successful outcomes. One example of difficult political decisions is the removal of production subsidies. Even though both financial and non-financial support is important at the development stage of an alternative fuel program, slashing subsidies after the industry is well developed, forces producers to become more efficient to compete against other agriculture producers in the world. Brazilian sugar producers experienced this situation and today they are among the most efficient producers in the world.

Another important political decision is how to create the necessary infrastructure to provide the fuel. If tax benefits for both producers and consumers are created, *flex-fuel* vehicles are manufactured, but gas stations are not able to provide the fuel, then the program can easily fail. Without sufficient filling stations carrying ethanol, distributors and car producers would have little incentive to promote the use of ethanol. The changes in infrastructure can be funded by increasing taxes or by mandating private companies to make the necessary changes. These are all political decisions that governments should make either by implementing regulations or designing fiscal policies that can undertake these issues.

Cooperation among the private and public sector is of great importance to increase consumer demand for alternative fuels faster. If the government and the private sector work together towards an alternative fuel program, the transition to have the fuel, the pump stations, and the vehicles available for consumers can be more efficient. In countries like the United States, automobile manufacturers such as General Motors (GM) and Ford Motors can be essential allies for the government to make ethanol a primary fuel source. In Brazil, the government was able to establish a relationship with automobile manufacturers by creating fiscal benefits to display ethanol-powered cars in their showrooms. The benefits obtained from this

link can be seen today on Brazilian roads; as *flex-fuel* vehicles continued to increase its market share year after year. This is an important lesson that countries interested in alternative fuels can learn from Brazil.

Today due to the high costs of oil, U.S. automobile manufacturers have lost market share to foreign companies such as Honda and Toyota. One reason is the fact that foreign companies have concentrated in more fuel-efficient vehicles including hybrids. While U.S. manufacturers have continued to promote their Sports Utility Vehicles (SUV). Creating tax benefits for domestic companies if more fuel-efficient vehicles or *flex-fuel* engines are created can help both the companies and the government in the promotion of ethanol as a fuel. GM for example has finally started to promote E85 vehicles⁴⁰ or *flex-fuel* with their slogan “*Livegreen, Go Yellow*”. This company has actually adapted their cars’ engines to be *flex-fuel* in other markets and has done very well in Brazil. For instance, GM in Brazil currently produces the most popular *flex-fuel* car sold in the country, the Celta 1.0 (Pfeifer). The company “closed 2005 producing more than 70% of its 11 models with a *flex-fuel* engine” (Pfeifer). It has taken a long time for GM to do the same in the United States, but it has finally realized, aided by new government subsidies for corn-based ethanol production, that changes must be implemented in this market. Cooperation among the government and domestic automobile manufactures can be a great step forward towards helping these companies to be competitive again and allowing the population to save money and help the environment with renewable fuel sources.

Countries like Argentina and the United States have been greatly affected by the current energy crisis. Hence, these countries have started to look for solutions to alleviate their energy challenges and reduce the negative impacts to their economies. For example, the ethanol

⁴⁰ E85 vehicles are adapted to run on E85 ethanol. E85 ethanol is a renewable fuel made from U.S. grown corn with a blend of 85% ethanol and 15% gasoline (General Motors).

program in Brazil was created after the country was significantly impacted by the increases in the price of oil during the 1970s. Today, Argentina and the United States are among the many countries affected by the increase of oil prices. Now they can both learn the positive and negative results that Brazil obtained while expanding the vision of ethanol for both consumers and producers in an era of high oil prices.

Energy Situation in Argentina

In Argentina, petroleum is the dominant source of energy, representing 88% of the country's energy supply. Among fuels derived from oil, diesel has a market share of 48% and is most commonly used among the cargo transportation industry, the agriculture sector, and public transportation (IICA/SAGPyA 26). Currently, there is a demand for diesel in Argentina of about 12.4 million cubic meters per year and by 2010 the demand should reach about 15 million cubic meters. However, there are concerns about the availability of these resources since it is estimated that Argentine oil reserves will last only 9.1 years and 10.2 years for natural gas (IICA/SAGPyA 26). Therefore, biofuels have become very attractive as an alternative source of fuel for this country (Table 4-1).

Biofuels in Argentina

With the energy uncertainties Argentina is experiencing, they are now promoting alternative fuels. On April 19, 2006, the Argentine Congress approved the Biofuels Act ("Es ley" 5-2). The Act promotes, through different fiscal incentives, the production of biofuels derived from soybeans, sunflower, cotton, sugar, corn, and other agriculture products. The legislation requires that all oil companies incorporate 5% of ethanol to regular gasoline and 5% of biodiesel to conventional diesel within a four-year period of the implementation of the law (Vidal 6). This Act is a vital step forward into developing a more significant alternative fuel industry in the country.

An important part of the current policy promoting biofuels is the regulatory aspect that mandates to add 5% minimum of biodiesel or ethanol to regular diesel or gasoline fuel (“Verde” 6). Currently Argentina has about 20 plants dedicated to the production of biodiesel, but they are mainly used for the production of fuel for agricultural machinery (“Es ley” 5-2). However, with the approval of the Biofuels Act new investments and projects should be created in Argentina to increase production.

Biodiesel in Argentina comes from soybeans, sunflower, corn, sugar, and other vegetable oils or animal fats. Argentina is a world leader in the production of oils from soybeans and sunflower, as well as other grains such as corn. As of April 2005/2006, the USDA estimated a soybean record production of 40.5 million tons (United States, “Argentina”). This situation puts Argentina in a favorable position to increase biofuels production due to its vast production of raw materials and the implementation of the Biofuel Act.

As one of the world’s leaders in the production of soybeans and corn, the country has a great opportunity to create a substantial supply of biofuel for its internal market and export (Huergo 19). As a result, analysts believe that with sufficient investment the industry will be able to produce enough to meet its demand. It is forecast that by 2010, the first year of the 5% blend mandate, local demand would be more than 600,000 tons annually of biodiesel (“Verde” 6). Also, demand for ethanol by the same year should reach 160,000 tons annually (“Verde” 6). According to Claudio Molina, current President of the Biofuel Association in Argentina, at least 18 plants with an average capacity of 35,000 tons yearly for biodiesel and four plants with an average capacity of 40,000 tons yearly of ethanol will be needed to meet internal demand (Molina 11). This could translate to a required investment of US\$ 80 million.

Global demand for biodiesel and ethanol is also expected to increase. The industry projects high demand of these fuels by 2010 and companies are beginning to make the necessary investment to catch these opportunities. Future market opportunities can also increase significantly if two second-generation hybrid soybeans are approved by the Argentine regulatory agencies (Rubio 5). These soybeans are currently in the early stages of evaluation in the field by the Argentine Secretariat of Agriculture and are expected to be part of a new technology that can help the industry tremendously. The characteristics of these two varieties include modified oil composition and higher oil-content (Rubio 5). Since these two varieties will meet the quality standards imposed by the European Union, it is expected that these second-generation soybeans will provide even more opportunities for Argentina to export biofuels.

Domestic Policy Environment

In April 2006, the Argentine government took the initiative in creating a Biofuels Act. This Act has various policy instruments and requirements designed to develop an industry capable of producing alternative fuels. Among the most important characteristics of this Act are that plants must be built and should be property of companies established in Argentina and capital for projects should come from companies dedicated to agriculture or agro-industry (Vidal 6). By following these requirements, biofuel producers would benefit from fiscal incentives such as accelerated depreciation and amortization capital expenditures for income tax purposes, as well as anticipated return of the value-added tax (VAT) (“Verde” 6). Other financial incentives include the distribution of limited production subsidies under the consideration of the Executive Power (“Verde” 6). The government also has the right to establish reference prices and allocate the amount of taxes the sector would be exempt from paying each year (Molina 11). The Act also mandates the creation of a commission as a regulatory agency that will be created to

promote production and sustainable use of biofuels, as well as supervise the industry (Molina 11).

This Act is the first legislation created by any government in Argentina to boost the production of ethanol and biodiesel. Since the Act is still in its first year since being implemented, further modifications may be necessary as the program develops. For instance, one of the early concerns from the private sector is the elimination of the fiscal stability incentive proposed in previous drafts reviewed in the Argentine congress (Molina 11). The new law will expose producers to different tax rates every year depending on the decision of the commission (Molina 11). The criteria of how the commission will assign the amount of taxes the sector would be exempt from paying each year is still unclear. This can make strategic planning more complex, hamper production, and turn away long-term investment. Another issue that some experts in Argentina have been concerned with is that the law concentrates primarily on small and medium business, making large oil companies uncertain about under what conditions they will be able to participate.

A positive environment for investors with clear fiscal and regulatory policies is of great importance for the effectiveness and future of a biofuels program in Argentina. Therefore, the government should look into all these issues and the evolution of the biofuel industry in order to make the necessary changes depending on results in order to make the program a success. The country is an agricultural power capable of producing enough raw materials for biofuel production. In addition, the Biofuels Act, an essential first step to promote alternative fuels has already been taken by the government. Lastly, as a neighboring country to Brazil and member of Mercosur, both countries can cooperate in the development of the ethanol industry in their countries and the rest of the world.

Energy Situation in the United States

Increasing ethanol use can benefit our environment, strengthen national security, and fuel the economic engine of free trade, creating a win-win-win for the United States and Florida (Enterprise Florida 1).

This was a message given by Florida Governor Jeb Bush after signing into law the 2006 Florida Renewable Energy Technology and Energy Efficiency Act. It is in fact an important step by the state of Florida recognizing the need of alternative fuel sources for the well-being of both the state and the country. Ethanol is indeed a technology capable of reducing the high levels of oil consumption in the United States.

The high price of oil and dependency of imported fuel is a situation that has brought much concern by politicians in this country in the past; however, the United States' dependence of oil after September 11, 2001 became an even more critical issue due to its national security. As of today, "America has used more oil than any other country over the last century, and it has only 2.7% of the world's remaining oil reserves" (Net 3) (Figure 4.1). Moreover, according to the U.S. Department of Energy, oil imports are projected to increase by one-third by 2020 even if increasing domestic oil production or drilling in places such as the Artic National Wildlife Refuge in Alaska and the Florida Gulf.

The need to invest in new fuels such as ethanol must be a priority for both the current and future administrations. The United States not only consumes 25% of all global production (Net 3), but the country has suffered economically from recent price fluctuations due to political events such as the anti-America rhetoric by presidents like Hugo Chavez and natural disasters such as Hurricane Katrina in 2005. Investments by both the government and the private sector in fuels such as ethanol can indeed serve as a short-term or medium-term solution to this energy crisis.

The Brazilian experience could be used as an example for the United States. By looking at what Brazil has done over the years, politicians in the United States can create similar laws but adapted to this country and this economy. Brazil's mission to substitute home-grown fuel such as ethanol for oil imports has been a priority for various Brazilian governments in the last three decades. Today, the lessons from Brazil previously discussed in this chapter can be used in the United States to produce an effective energy plan that will alleviate the impacts to the economy due to oil price fluctuations. Brazil not only can serve as an example for the United States, but cooperation among these countries can be great importance to bring faster energy solutions for these countries and the world.

Biofuels in the United States

Corn-based ethanol is the primary biofuel in production in the United States. Today, ethanol production makes up about three percent of the U.S. annual gasoline usage (Baker and Zahniser). As of 2005, the United States consumed about 139.9 billion gallons of conventional gasoline and 4.04 billion gallons of ethanol (Baker and Zahniser). To expand biofuels production in the United States, the government created an Energy Policy Act in 2005 that established a federal mandate that require a certain amount of biofuel consumption. Both the President and the U.S. Congress mandated that consumption of biofuels should reach 7.5 billion gallons by 2012.

At the USDA's Agriculture Outlook Forum⁴¹ held in February 2006, one of the most important conclusions was that biofuels growth in the United States has surpassed all expectations. The production of biodiesel for instance went from about half a million gallons in

⁴¹ This forum was held on February 16th and 17th with more than 130 speakers including Agriculture Secretary Mike Johanns, former U.S. Trade Representative Robert Portman, President of the National Corn Growers Association Gerald Tumbleson, and many others.

1999 to more than 70 million gallons in 2005 (Rebolini and Romanella 28). The U.S. ethanol sector on the other hand used about 14% of the total corn harvest in 2005⁴² with an annual capacity of 4.4 billion gallons. Actual ethanol production in 2005 was a record 3.9 billion gallons (United States, “Ethanol Production”). Plants under construction or expansion will likely add about 2.1 billion gallons to the current capacity (Baker and Zahniser). The USDA estimates that ethanol will increase its use of raw materials to about 50% of corn production in the next ten years. These increases are part of President’s George W. Bush mandate “to replace more than 75% of [the United States] oil imports from the Middle East by 2025”⁴³ (United States, “State”). In fact, if existing and anticipated policy incentives in support of ethanol production continue, capacity could reach 7 million gallons per year by 2010. Currently there are 101 ethanol plants operating in 20 states. Among the most important states producing and selling ethanol in the United States are Minnesota, Iowa, Illinois, and Nebraska (Lundegaard) (Figure 4.2). In addition, 39 ethanol plants are under construction and another 7 facilities are under expansion (Collins 8).

There have been different factors that have influenced the decision to increase ethanol production in the United States. An obvious one is the high oil prices that have impacted both producers and consumers in the United States. Other factors have been low corn prices, the Renewable Fuels Standards (RFS) under the Energy Policy Act of 2005, and the creation of other policy tools implemented for the promotion of alternative fuels. This situation has indeed created a new interest for ethanol and other biofuels in general in the United States. The current

⁴² About 1.6 billion bushels of corn was the production in 2005 (Baker and Zahniser)

⁴³ This goal was set by President George W. Bush in his State of the Union speech in January 31st, 2005.

emphasis in ethanol production and oil price fluctuation has made biofuels more cost competitive with gasoline and it has stimulated investments in the industry.

With expectations of oil keeping its prices above US\$ 50 per barrel in the next few years, an increase in the use of alternative fuels should be a priority. Today, ethanol is often seen as the most viable alternative fuel to replace oil. As a result, the U.S. government is making political decisions to promote this option. Some of these decisions might be popular policies such as tax breaks, while others could be political choices that often politicians have not preferred such as higher gasoline taxes. The U.S. government has started to send messages through Presidential speeches or different policy tools about the importance of ethanol for the country. However, more political decisions and commitment, as well as cooperation with the private sector and foreign governments like Brazil need to prosper in order to increase the significance of ethanol for the United States.

Domestic Policy Environment

In 2005, President George W. Bush signed the Energy Policy Act calling for the Advance Energy Initiative (AEI). The President reinforced the importance of alternative fuels in his State of the Union speech in 2006. Although these developments are a good step forward, more still needs to be done by the government to alleviate the country's oil dependency in a near future. Various alternative fuel sources are considered in the Energy Policy Act, but corn-based ethanol is currently the most viable biofuel that can be produced in the country. Section 1501 of the Act encourages the private sector to produce the fuel by requiring the use of ethanol in the short and mid term future. This segment of the Act sets a Fuel Requirement Standard (FRS) for each year through 2012 requiring that "gasoline sold or introduced into commerce in the U.S. on an annual average basis, contains the applicable volume of renewable fuel determined" (Enterprise Florida

2). This means that the new standard set by the Act will increase the use of U.S. corn-based ethanol from 4 billion gallons in 2006 to 7.5 billion gallons by 2012.

Other federal incentives have been created since 2005 for the promotion and development of alternative fuels in the United States. The Alternative Fuel Infrastructure Tax Credit, which is part of the Energy Policy Act of 2005, provides tax credit equal to 30% of the cost of alternative refueling property, business property, or residential refueling equipment (United States, “Federal E85”). Another incentive also from the Energy Policy Act of 2005 is the Biodiesel and Ethanol Tax Credit or section 1344. This segment of the Act extended the tax credit for biofuel producers through 2008. The credits are US\$ 0.51 per gallon of ethanol, US\$ 1.00 per gallon of agri-biodiesel, and US\$ 0.50 per gallon of waste-grease biodiesel (United States, “Federal E85”). All these incentives and much more are necessary to continue the promotion of alternative fuels in the United States.

Florida, as well as many other states in the country, is also looking into the business opportunities biofuels can offer. According to the conclusions presented at an energy forum at the University of Florida, the state “can be a leader in alternative fuels made with everything from orange peels to yard waste” (Crabbe 7A). Plans to build ethanol plants in the state in cities like Tampa and Jacksonville are on their way. Moreover, the first E-85 pump of the state opened in Tallahassee on September 13th, 2006. Governor Bush has been a strong advocate for this fuel and believes that “diversifying the nation’s fuel portfolio is essential for the country’s national security and economy” (Bush 1).

Today, up to seven percent of U.S. consumption of ethanol can be imported without tariffs from countries associated with the U.S.-Caribbean Basin Trade Partnership Act (CBTPA) and from member countries of the U.S.-Central America Free Trade Agreement (CAFTA) (Kabel).

As a result, companies producing ethanol in Brazil are looking for ways to build ethanol plants in these countries to avoid the US\$ 0.54 per gallon tariff the United States imposes on imported Brazilian ethanol (Kabel). In addition, the United States also collects a 2.5% ad valorem tariff on ethanol imports (Latin America Advisor). However, there have been debates in the U.S. government regarding the effects of this tariff. While politicians such as Saxby Chambliss from Georgia argue that the tariff should be imposed to protect U.S. farmers (Latin America Advisor), other politicians believe that more ethanol should be imported in order to meet demand for ethanol as a gasoline additive. Instead of protecting the industry through import tariffs, the government should look for a partnership with Brazil in order to speed up the development of the ethanol industry in the United States. By slashing the current tariff, the U.S. ethanol producers for instance, will face competition from Brazilian producers. This situation will create a incentive for U.S. producers to invest in technologies to advance the U.S. industry. Moreover, by removing the tariff, a better relationship in this area among the two countries could be created in order to develop new technologies to reduce production costs, create a more efficient ethanol market, and increase the supply of the fuel in the future.

Creating new policies to promote alternative fuels in the United States should become a priority for members of the government. Even though some members of the government have taken initiatives to promote alternative fuels, much more still needs to be done in order to have this fuel as a reliable alternative. Ethanol not only can help the United States in aspects of national security, but it can also bring economic benefits in rural communities with agriculture-based economies. Aggressive policies as well as cooperation with foreign countries such as Brazil are necessary to create a successful program. This fuel is indeed an option that can help

solve environmental issues and the current challenges related with the economy and the national security of this country.

Set of Policies Implemented by Argentina and the United States

When looking at Argentina, Brazil, and the United States, there are significant differences among the three countries. For instance, Argentina is a country that had a net foreign direct investment in 2004 of US\$ 1.8 billion compared to Brazil's US\$ 7.100 billion (McCoy 42). In terms of GDP growth rates in 2004, Argentina grew at an 8.2%, compared to Brazil's 5.2% (McCoy 43). On the other hand, the United States had a GDP growth rate of 3.4% in 2004 (EIU, "Economic"). Other factors such as country risk, currency risk, or political risk are also important differences among these three countries. Therefore, the implementation of policies or programs to promote alternative fuels in each of these countries depend on their political and economic environment, as well as resources available by each government.

In the last three decades of the PNA, Brazil implemented a set of policies that targeted three main groups: producers, distributors, and consumers. Each policy helped the ethanol program to develop to what it is today. The Brazilian government created both regulatory and fiscal policies to promote the production and consumption of ethanol. Among the most important regulatory policies designed for both producers and distributors were: blend ratios, price policy, production quotas, and environmental policies. Fiscal policies were also created to target producers and distributors: financing policies, fuel taxation, and government research funding. Lastly, consumer oriented policies were essential for the development of the ethanol program in Brazil. The government created a price policy as a regulatory measure and vehicle and fuel taxation policies. Each of these policy instruments were implemented at different stages of the program since the government had to adapt to various economic and political cycles.

In the case of Argentina, the new Biofuels Act is intended to expand the country's biofuel industry. As the first governmental act created in Argentina on this matter, the law has become a vital first step towards promoting alternative fuels. However, the Act could eventually see changes in the future in order to adapt to the needs of the industry or the country. This new Act implements two important policies that were used by Brazil. The first one is a blend ratio policy, a regulatory measure that forces all oil companies to mix 5% of biodiesel or ethanol to conventional diesel or conventional gasoline by 2010. The second measure is a financing policy that benefits both producers and distributors in order to expand the industry. The idea behind this fiscal policy is to support the industry in its early stages of development. This is indeed a similar path that Brazil took after 1979. One major difference is that this Act was not design to create incentives for consumers. Since the law mandates companies to blend all conventional fuels with biofuels, consumers will not have to make a choice when buying diesel or gasoline. Nevertheless, future policies should include consumers in order to create a more efficient market for the fuel.

The United States has created a more complete set of policies to promote alternative fuels. The Energy Policy Act signed by President Bush in 2005, was designed with a set of incentives and regulations targeted to producers, distributors, and consumers. The Act has a series of regulatory and fiscal policies with financial incentives in order to speed up the development of the industry. One regulation is the blend ratio policy established in Section 1501 of the Energy Policy Act that requires a certain percentage of ethanol be added to conventional gasoline. This percentage will increase each year through 2012. The maximum blend ratio as of today is 10% ethanol 90% gasoline. The reason is that all gasoline cars sold in the U.S. can run on a 10%

ethanol mix without an engine adjustment (Enterprise Florida 2). The government expects an increase of 7.5 billion gallons of ethanol by 2012 as a result of this regulation.

In addition, fiscal policies designed to create incentives for producers and consumers are also part of the energy Act in the United States. Among the fiscal policies designed to influence the supply-side are government research funds. This is a policy that the United States was able to create by allocating funds to research institutions and universities in order to find new technologies. This is indeed a policy that could bring results in the near future just like it happened for Brazil. The other set of policies oriented for both producers and consumers are taxation policies. The current administration has used tax policies to give incentives to the population to either producer or consume ethanol. This instrument has created tax benefits for producers such as corn growers in the Midwest states. In addition to the production subsidies they already received, producers are entitled of tax benefits if they engage in ethanol production.

Tax policies were also designed to attract consumers into buying *flex-fuel* vehicles. Today, consumers can benefit from tax credits by purchasing the several E85 models offered by automobile manufactures. Even though these policies are only a couple of years old, the government is expecting positive results in the next six years. The high price of oil, together with both regulatory and fiscal policies created by the U.S. government, should bring dividends in the near future just like it did for Brazil. However, even though these policy instruments are a good start, more will still need to be done in order to adapt the changes in the economy and in the industry.

Table 4-1. Argentina's Distribution of Diesel Consumption per Sector (2004)

Cargo transportation	56%
Agriculture sector	20%
Transportation system	14%
Automobile	6%
Train	2%
Ships and energy generation	2%
Total	100%

Source: IICA/SAGPyA, 2005

Table 4-2. Argentina's Consumption of Hydrocarbons Resources (2004)

Product	Cubic Meters (in millions)	Market Share
Diesel	11.4	48%
Gasoline	3.4	15%
Natural Gas	3.1	13%
Kerosene	1.3	6%
Fuel Oil	1.1	5%
Petroleum Coke	1.1	5%
Propane	0.65	3%
Butane	0.40	2%
Others	1.0	5%
Total	23.7	100%

Source: IICA/SAGPyA, 2005

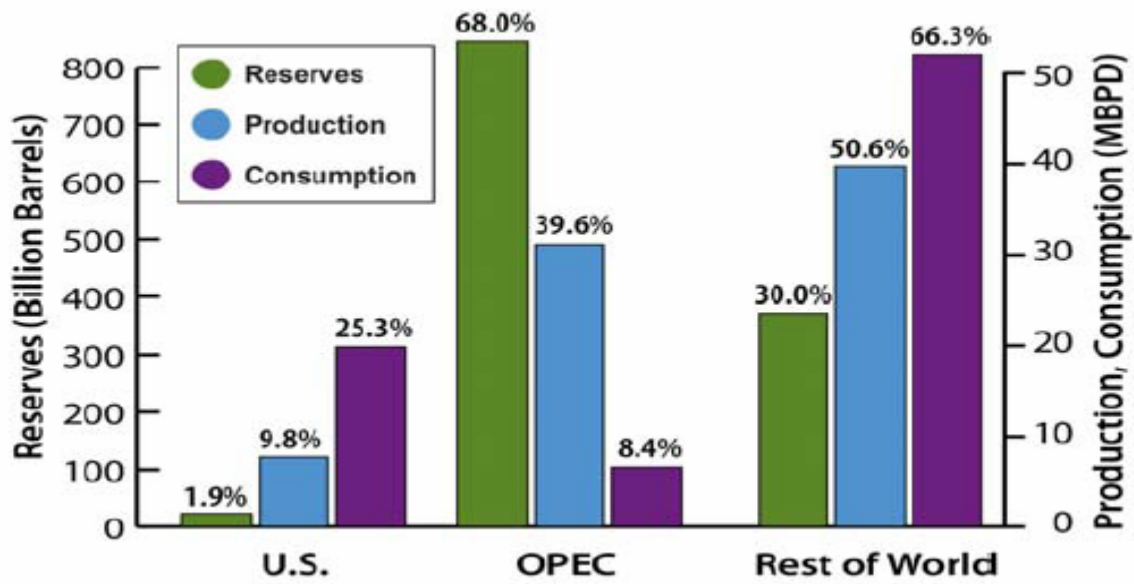


Figure 4-1. World Oil Reserves, Production, and Consumption (2003) Source: Enterprise Florida, 2006.

Fueling Up With Ethanol

More than 600 gasoline stations in the U.S. now also sell the ethanol mix known as E85. Most are concentrated in the Midwest.

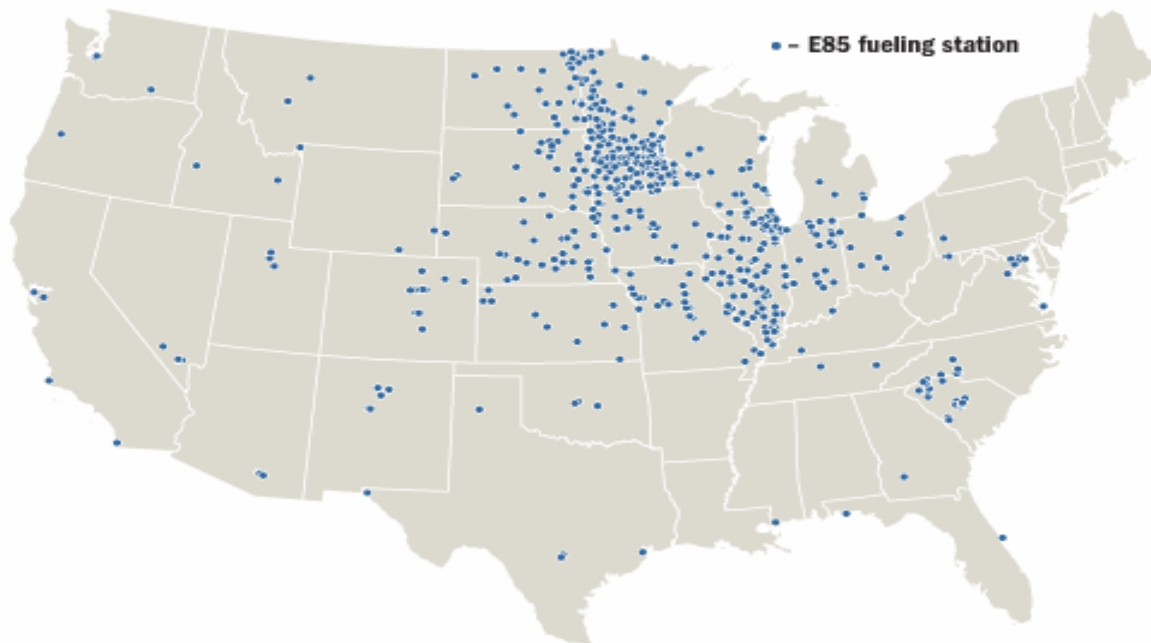


Figure 4-2. E85 Gasoline Stations in the United States. Source: Karen Lundegaard, 2006

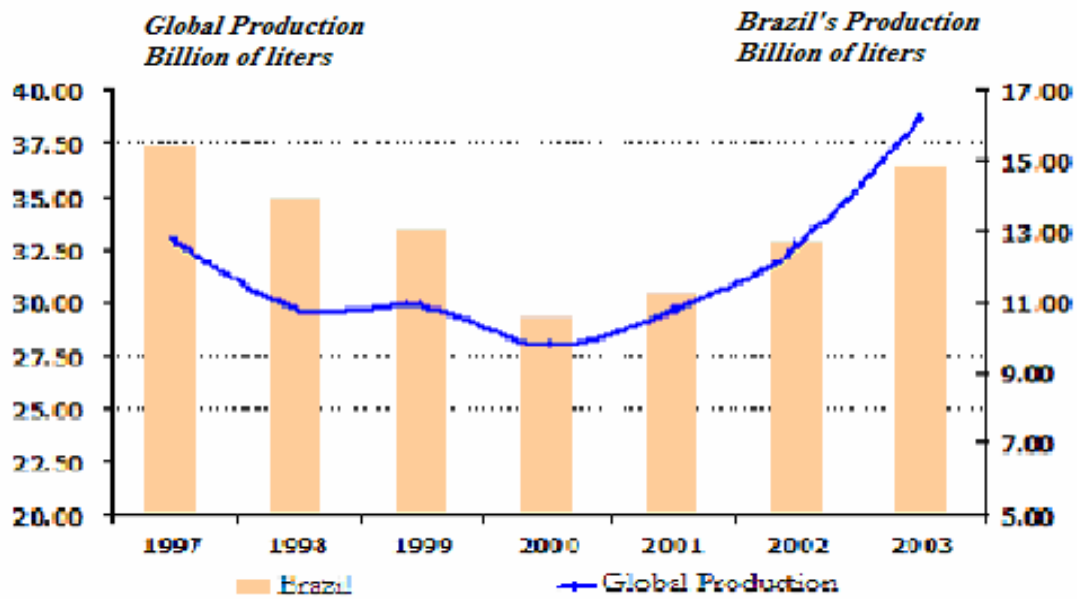


Figure 4-3. Global Production of Ethanol (1997 – 2003). Source: Plinio Mario Nastari, 2004.

CHAPTER 5 THE END RESULT (THE BRAZILIAN EXPERIENCE)

Brazil has pioneered the use of ethanol produced from sugarcane. Government policies and partnerships between public and private institutions throughout the years have provided the foundation for the development of this successful industry which has helped the country in many ways. In fact, all the regulations and incentives created by the government have indeed maintained this program running even in the bad times. However, the various changes in the economic and political environment of Brazil have also resulted in unintentional outcomes for the PNA.

Since 1975, ethanol has been considered by most Brazilians as the most suitable substitute fuel not derived from oil. Today, the government emphasizes how the ethanol program has a positive effect on the balance of payments and economic growth for Brazil. Moreover, the ethanol program has created new employment opportunities and has initiated rural development in some of the poorest regions of Brazil. Since its start, the program has gone through a variety of stages during which Brazilians have doubted its success. Nevertheless, the government's commitment and policies have allowed ethanol to still be a credible renewable energy source.

One major finding in this research is the various factors that have affected the ethanol program and the government's response. One key factor that affects ethanol planning is the price of oil and the price of sugar. The relationship of these two commodities has influenced the industry and the decisions taken by the government. For instance, as prices of oil went up during the 1970s and 1980s, the Brazilian government opted to look at ethanol as a solution in order to reduce the impacts to their economy. On the other hand, when prices of oil went down during the 1990s, ethanol funding programs stopped being a priority for the government. The price of sugar also affected the ethanol production in Brazil. As raw sugar prices continued to increase at

times, producers were inclined to sell it in the international sugar market to obtain higher profits. As a result, the government needed to regulate production and create incentives for producers to provide sugar to the ethanol industry.

In order to control these factors, the government was involved in the market by creating financial and non-financial incentives for producers. However, some of the outcomes obtained from the policies implemented resulted on unintended consequences. For instance, when the government reduced public funding for the ethanol program in the 1990s, Brazilian producers were able to become more efficient than ever before. This efficiency in Brazil carried into the new millennium and today Brazil is still a leader in ethanol production.

Another important finding is that the Brazilian experience could serve as a guideline for other countries to create alternative fuel programs but not a model. After looking at the ethanol history in Brazil and the current biofuels situation in countries like Argentina and the United States, it is important to notice that each country is different. Each of these countries have different resources, different economic environments, a different political system, and a different political will. Therefore, the Brazilian experience could not serve a blueprint for the rest of the world. Instead, other countries could see Brazil as an example and could work with the Brazilian government on common goals on energy solutions by cooperating with each other. These guidelines are significant for several reasons: reduce economic and environmental pressures, and global security. If countries use Brazil as an example, and countries cooperate with each other in order to create an important market of ethanol, positive results could be obtained in the near future. Countries like Argentina and the United States have started to promote biofuels production and consumption. Brazil continues to be a leader in the production and consumption of ethanol as an alternative fuel. These countries need to continue pushing for a change and a

diversification of energy sources. Therefore, Brazil's experience could serve as a guide for other countries interested in alternative fuel programs.

Over the years, Brazil has developed new technology that has allowed it to make affordable fuel mixtures for its domestic consumption. As a result, the domestic market for ethanol is booming and already accounts for some 40% of non-diesel automotive fuel volume (EIU, "Ethanol-fuelled"). Together with the Brazilian government, the sugar and automobile industries are investing significant capital to make this 30-year old industry more significant for Brazil and the world. Thus far, this promising renewable fuel seems as an alternative able to reduce countries' dependence of oil; Brazil, through its long experience with ethanol, positioned itself as the only one now capable to take it around the globe.

For the past thirty years, the country has concentrated in replacing the demand of gasoline for alternative fuels. Since the energy crisis of the 1970s and through the current energy concerns of the 21st century, the government's mandates have resulted in over US\$ 10 billion invested in new sugar mills as well as modern fuel pumps in order to increase consumer awareness (Enterprise Florida 6). About half of Brazil's 21,000 square miles of sugarcane is used to make ethanol and in 2005 the country exported about 2.6 billion liters (Brazil, "Brazilian Agribusiness"). Today, the country's 304 refining plants⁴⁴ represent a production capacity of about 17 billion liters per year (Barros 1). Currently, more than 29,000 filling stations offer both hydrous ethanol and gasoline mixed with 20% anhydrous ethanol. In the United States for instance, over 600 filling stations offer E85 fuel⁴⁵ (Enterprise Florida 6). This comparison shows a great gap between the two leading producers of ethanol in the world. Today, more than 80% of

⁴⁴ 61% of these plants are located in the state of São Paulo.

⁴⁵ A blend of 15% gasoline and 85% ethanol.

new cars sold in Brazil can run with both gasoline and ethanol, in contrast less than 2% of cars in the United States can run on E85 (Harri).

Brazil's strong position with ethanol is also of great importance for the world in terms of helping the environment, reducing oil dependency, and promoting trade. In 2004, the Brazilian sugarcane harvest produced 416 million tons, 91% of which was used to produce 26.5 million tons of sugar and 15.2 billion liters of ethanol (Brazil, "Brazilian Agribusiness"). Moreover, as global demand for ethanol increases, Brazil is adapting to these changes. In the next three years, 40 new plants are due to enter production in the country (Brazil, "Brazilian Agribusiness"). Lastly, Brazil's strong position in the world economy and ethanol production has helped them become more active in trade negotiations. In order to expand sugar and ethanol exports, the country is aggressively seeking to reduce global protectionism and unfair commercial practices, particularly in agriculture commodities.

Brazil has become an example in this era of high oil prices and environmental challenges. In the past year, there has been rapid change in the way in which alternative fuels are promoted. In the United States, where people have been very affected by high gasoline prices, both the public and private sector are seeking ways to find a solution to the country's oil dependence. Other countries like Japan and India are also interested on ethanol to reduce their oil bills and to alleviate its environmental problems. Brazil is indeed well ahead of these countries and its history and experience serve as an example and a model to follow in the immediate future.

As previous mistakes or misfortunes by Brazil are now becoming part of history; the future for ethanol and the country looks promising. For instance, the hydrous-ethanol powered cars that were produced in the mid 1980s represent just a 3% of the current market in Brazil (Lynch). In contrast, the *flex-fuel* cars took 53.6% of the Brazilian market in 2005. In all, 866,267 *flex-fuel*

cars were sold in 2005 against 328,379 the year before (“More Cars”). Companies such as Volkswagen, Fiat, General Motors, and Ford Motors have launched a range of more than 40 *flex-fuel* models within the last two years. In addition, Toyota Motors and Honda Motors have recently started to build *flex-fuel* vehicles in Brazil (Lundegaard). In the medium term, it is expected that *flex-fuel* cars would obtain an 80% share of the market since the cars are no more expensive than traditional gasoline cars. Moreover, gasohol and hydrous ethanol is still sold at almost half the price of conventional gasoline (EIU, “Ethanol-fuelled”).

Ethanol is also creating new investments opportunities for foreign and domestic firms in Brazil. Big sugar producers such as French companies Tereos and Louis Dreyfus are making significant investments. Both firms have invested about US\$ 150 million in Brazil in the last four years. There are growing opportunities in the future as ethanol becomes an important trade commodity for the world. With countries searching for ways to reduce environmental challenges and oil dependency, ethanol has become more than just an attractive idea. According to the São Paulo Sugarcane Agroindustry Association (UNICA), investment in sugarcane in Brazil will reach US\$ 3 billion by 2010 (EIU, “Ethanol Producers”).

Now that Brazil has shown the world its achievements, we see hundreds of articles in newspapers all over the world explaining how they did it. The United States for instance, second largest producer of ethanol in the world, is now debating and looking for ways to achieve the same in a time when energy costs are creating problems for its economy. Brazil in the other hand is looking for markets around the world to sell ethanol and create a market for this commodity. As more political events, natural disasters, or shortages of oil supply occur, the world will continue to face energy crisis in the future. Countries around the world, including Brazil, will face more energy challenges along the way. However, after looking at how the

Brazilian government has managed its ethanol program and adapted its policies in the last three decades, we can expect the Brazilians will find ways together with the private sector to assure the continuation of this successful ethanol program. Good policy management to promote alternative fuel programs is indeed a very important aspect towards reducing oil addiction in many countries around the world.

APPENDIX
ETHANOL IN BRAZIL

Appendix A-1. Timeline

Date	Event
November 1973	First Oil Shock
November 14, 1975	Creation of the National Alcohol Program (PNA)
1979	Second Oil Shock
1979 to 1981	Institutional Crisis for the PNA
1980s	The “Lost Decade”
1982	Mexican Debt Crisis
1982 to 1985	Period of Adjustment for the PNA
1990s	New Reforms (Washington Consensus)
1997	Asian Crisis
1997	Price Liberalization of Hydrated Ethanol
1999	Price Liberalization of Anhydrous Ethanol
1999	Elimination of Ethanol Distribution Monopoly by Petrobras
2003	Introduction of <i>Flex-fuel</i> Technology in Manufactured Vehicles in Brazil
2006	Leader in Global Ethanol Production

Appendix A-2. Brazilian Ethanol Policy Diagram

	Producer and distributor oriented policies	Consumer-oriented policies
Regulatory policies	Blend ratios Price policy Production quotas Environmental policies	Price policy
Fiscal policies	Financing policies Fuel taxation Governmental research funding	Vehicle taxation Fuel taxation

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BIOGRAPHICAL SKETCH

Nicolas E. Rubio was born on August 9th, 1981 in Caracas, Venezuela. The older of two children, he grew up part in Caracas, and then moved to Miami, Florida, graduating from Miami Coral Park Senior High in 2000. Nicolas moved to Gainesville and began his college experience as a Florida Gator in August 2000. He earned his B.S. in Economics from the Warrington College of Business at the University of Florida (UF) in May 2004. While in his undergraduate years, Nicolas got to experience other cultures by either participating in study abroad programs in the Netherlands and Brazil, or traveling to other countries in Latin America such as Mexico and Argentina.

Upon graduating in May 2004, Nicolas was accepted by the Center of Latin American Studies in UF to start his Master of Arts in Latin American Studies with a concentration in Business Environment. As a graduate student, Nicolas became a Teacher Assistant (TA) for the Department of Romance Language and Literature. As a TA, he instructed six sections of first level Spanish for three semesters. Moreover, he became the Program Coordinator of the Partnership in Global Learning Project (PGL) in August 2005. Among the many tasks, he facilitated training sessions through video-conferences for program's teachers in Brazil, Mexico, and the United States. Lastly, Nicolas also had the opportunity to work for the USDA/Foreign Agriculture Service (FAS) in Washington D.C. and in Buenos Aires. In the summer 2005, Nicolas became an intern at the International Cooperation and Development Division of FAS in Washington D.C. At the end of his internship, Nicolas received the Teamwork Award and the Intern of the Year Award. Then in February 2006, Nicolas worked at the U.S. Embassy in Buenos Aires as an intern of the FAS office. While in Buenos Aires, Nicolas was able to conduct research in different agriculture areas for the office. Upon completion of his M.A.

program in December 2006, he will move to Washington D.C. to start working as an Analyst for Accenture.