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### Flex Cars and the Fuel Market in Brazil

#### 2.1

##### Flex Cars

After the first oil crisis, the Brazilian government launched the National Ethanol Program in 1975, known as Pró-álcool (“Pro-ethanol”). The main objective of this program was to replace oil derivatives for an alternative and renewable energy source, reducing the volume of imported oil. Investments were made by the government to expand sugarcane cultivated areas and to build ethanol distilleries. The program was strongly subsidized by the Brazilian Government.

In 1978 the first car equipped with an engine that could run purely on ethanol was released. By 1984, vehicles with ethanol-powered engines accounted for approximately 94% of overall production by the Brazilian automobile industry.

After 1986 the program started to lose its drive as oil prices stabilized and began to fall. Ethanol production stopped growing but the automobile industry continued to produce ethanol-powered cars. This led to ethanol supply crisis and to a plunge in the sales of ethanol-powered vehicles. By the mid nineties, the government was forced to review the program and it was almost abandoned. In 2001, sales of ethanol-powered cars corresponded to about 1% of total new vehicle sales in Brazil.

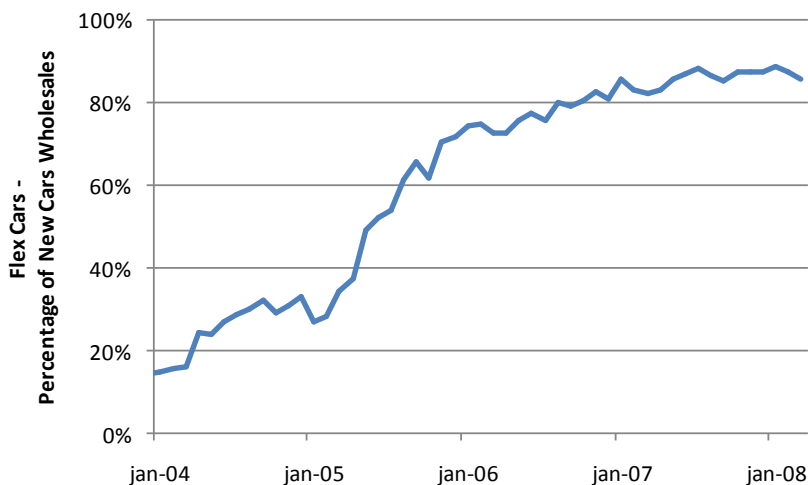
In the first quarter of 2003 the flex cars (or bi-fuel cars) were released. This type of vehicle is designed with an engine that can run on both gasoline and ethanol and on any mixture of the two fuels. The tank of a

flex fuel car has a sensor that is capable of identifying the exact fuel combination at any time. The engine is then automatically adjusted according to the fuel mixture.

Ever since its release, sales of bi-fuel have significantly grown, as we can see in the graph shown below. In 2007 it accounted for 86.1% of total new automobiles and light vehicles wholesales, according to the National Association of Motor Vehicles Producers. That percentage is even higher when it is related to automobiles only, reaching 91.3%.

It is important to say that sales of new vehicles is the main cause of increments in the stock of flex fuel automobiles. It is not a common practice to convert mono-fuel cars to bi-fuel, despite being technologically feasible<sup>1</sup>.

**Figure 1: Flex Cars Wholesales as Percentage of New Cars Wholesales - Including Only Cars and Light Commercial Vehicles**



Flex cars owners can use the fuel that offers the lower cost per kilometers (or miles) driven<sup>2</sup>. Based on some raw data amass, comparing

<sup>1</sup> It is also technologically feasible and much more common in Brazil to convert cars to run on compressible natural gas, an alternative fuel.

<sup>2</sup> There are other facts that might influence consumers into choosing one fuel instead of the other. A car running on ethanol is less hazardous to the environment and more powerful. A car powered by gasoline demands less fuel, thus allowing for less frequent refueling. Even though

the available bi-fuel cars, it will be financially advantageous to run on ethanol whenever it costs less than 70% of the gasoline price, as described by Marjotta-Maistro and Asai (2006).

## 2.2

### Fuel Market

In Brazil, ethanol is made from sugarcane fermentation. Two kinds of ethanol play a role in the automotive fuel market: anhydrous and hydrated<sup>3</sup>. Anhydrous ethanol is sold to distributors and then mixed with gasoline (currently in the proportion of 25%, but this percentage has varied according to regulation). Hydrated ethanol is also sold to distributors but it is not mixed with any other fuel. In distributors, it is sold to fuel stations. Hydrated ethanol is the kind of ethanol found by consumers in pumps at fuel stations.

The production and distribution of gasoline in Brazil works as follows: crude oil is refined and from this process gasoline is obtained along with several different products such as diesel, kerosene, etc. The refineries then negotiate the gasoline with fuel distributors, which can also import gasoline. Until this point, gasoline is denominated “gasoline A”. In distributors, gasoline A is mixed with anhydrous ethanol. From this point on, gasoline receives the denomination of “gasoline C”. Then, distributors will be in charge of selling gasoline C to fuel stations.

It is necessary to highlight that whenever we refer to gasoline we are considering gasoline C and whenever we refer to ethanol we will be talking about hydrated ethanol.

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the arguments previously mentioned affect consumers’ choice, we believe that they are second order effects.

<sup>3</sup> The main difference between the two kinds of ethanol is the percentage of water that each one has. The anhydrous percentage of water is lower than the hydrated one.

Except from periods during the ethanol supply crisis previously mentioned, Brazil has always been a net exporter of ethanol. On the other hand, Brazil was a net importer of oil until 2006. Since then, Brazil reached self-sufficiency and became a net exporter of oil.

The fuel market in Brazil, which had its prices controlled by the government for many years, started to be liberalized at the beginning of 1996. Hence, several legal acts entered into force to introduce a new regulation to the sector. From January 2002 onwards, regulators allow for free settlement of prices related to fuel production and commercialization, which meant "...the end of governmental intervention in the fuel sector", according to ANP. This last statement is not entirely true, since Petrobras still exerts pressure on gasoline prices.

Petrobras is an enterprise controlled by the Brazilian government that was created in 1953 together with a law that assured the company monopoly powers of exploitation, refinement and transportation of oil and its derivatives. Later in 1963, a law also granted monopoly powers of import and export of these same products. It was only in 1997 that this monopoly ended. During this monopoly period, Petrobras became the major fuel company in Brazil and one of the largest in the world. Only two out of fourteen oil refineries in the Brazilian territory do not belong to Petrobras. So, it is not surprising to find out that this company is the major gasoline seller in Brazil and at least some of its pricing decisions are influenced by the government.

### 2.3

#### **Flex Cars and Competition between Ethanol and Gasoline**

The owner of a flex car chooses the fuel that offers the lowest cost per driven kilometer (or miles). From this perspective, we can interpret

ethanol and gasoline as being perfect substitutes to consumers that own this type of vehicle.

We claim that as the proportion of bi-fuel cars increases, so does the degree of substitution between gasoline and ethanol faced by the average fuel consumer. Thus, an increase in the proportion of flex fuel cars will result in a larger cross-price elasticity of demand between gasoline and ethanol. This implies that aggregate demands for ethanol and for gasoline will be more elastic.

Fuel stations will also be affected by the raise in the percentage of flex cars. Considering that the fuel retail market in a given city is imperfectly competitive, we expect that stations will respond by strengthening the competition between them as they perceive a higher degree of substitution between gasoline and ethanol on the demand side. Consequently, lower fuel prices will be charged in this new equilibrium. Fierce competition will also imply higher correlation between gasoline and ethanol retail prices.

With that in mind, we verify the competitive effect of the introduction of flex fuel cars on the ethanol and gasoline retail markets. More specifically, we estimate a reduced form model to test the hypothesis that an increase in the percentage of flex automobiles reduces ethanol and gasoline prices and increases the sensitivity between them. Both effects are consistent with the interpretation of strengthened competition between gasoline and ethanol.