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Another driver of the Brazilian fuel ethanol supply chain: the consumers' preferences

Influenciando a Cadeia Brasileira de Abastecimento de Etanol: As Preferências dos Consumidores

Influencia de las preferencias de los consumidores en la cadena de suministro de etanol en Brasil

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Abstract

Many factors have been discussed in the literature as the causes for setbacks in the Brazilian ethanol supply chain, such as the low price of petroleum and the high price of sugar in the financial crisis in 2008. However, there is an important gap that was not explored yet, how do drivers choose to refuel their cars? Do the supply chain managers know their consumers? Based on that, this paper aims to demonstrate how the ethanol supply chain stakeholders perceive consumers' preferences and compare them to the factors that are taken into consideration by Brazilian flexible-fuel vehicles drivers when choosing types of fuel gasoline or ethanol. For that, we illustrated the case by using a sample of announcements collected from Brazilian news media featuring the supply chain managers' view and the survey taken by drivers to understand the consumer's actions. Our results indicate that there is a significant difference between the actual preferences of fuel consumers and the perceived consumers' preferences by the stakeholders. This disparity is probably the (or one of the) main cause of the second setback in the Brazilian supply chain (2009–2012). Based on these results we point out the strategic implications in managing this supply chain and also the role of public policy in improving the diffusion of ethanol in Brazil.

Keywords: Choice; Consumer behavior; Energy; Ethanol; Gasoline; Supply chain

Resumo

Muitos fatores têm sido discutidos na literatura sobre as causas de obstáculos na cadeia de suprimento do etanol brasileiro, como por exemplo, o baixo preço do petróleo e o preço elevado do açúcar durante a crise financeira de 2008. No entanto, há um importante fator que pode também ser um obstáculo, mas que não foi explorado até o momento, o consumidor. Como motoristas escolhem reabastecer seus carros? Será que a ponta inicial da cadeia conhece os seus consumidores? Neste trabalho tem-se como objetivo demonstrar como os intervenientes da cadeia de fornecimento de etanol percebem as preferências dos consumidores, e compará-las aos fatores que os motoristas de veículos *flex* brasileiros apontam como

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relevantes na escolha dos combustíveis. Para isso, utilizou-se uma amostra de anúncios recolhidos a partir de meios de comunicações brasileiros que caracterizam as percepções dos gestores da cadeia de fornecimento e uma amostra com motoristas para entender as ações do consumidor. Como resultado, observou-se que há uma diferença considerável entre as preferências atuais dos consumidores de combustível e as preferências do consumidor percebidas pelas partes da cadeia de suprimento de etanol. A disparidade é provavelmente mais uma das causas do segundo revés na cadeia de abastecimento do Brasil (2009-2012). Com base nestes resultados destacam-se as implicações estratégicas na gestão desta cadeia de suprimentos e também o papel das políticas públicas na melhoria da difusão de etanol no Brasil.

Palavras-chave: Escolha; Comportamento do consumidor; Energia; Etanol; Gasolina; Cadeia de suprimentos

Resumen

Mucho se ha discutido en la literatura sobre los factores que producen obstáculos en la cadena de suministro del etanol en Brasil, como por ejemplo, el bajo precio del petróleo y el alto precio del azúcar durante la crise financiera de 2008. Sin embargo, existe un importante factor que también puede constituir un obstáculo, pero que no ha sido explorado hasta el momento, el consumidor. ¿Cómo los conductores eligen recargar combustible? ¿Será que el punto inicial de la cadena conoce a sus consumidores? En este trabajo el objetivo es demostrar cómo los actores de la cadena de suministro de etanol perciben las preferencias de los consumidores y compararlas con los factores que los conductores de vehículos *flex* brasileños señalan como relevantes en la elección de los combustibles. Para eso, se ha utilizado una muestra de anuncios recogidos a partir de medios de comunicación brasileños que caracterizan las percepciones de los gestores de la cadena de suministro y una muestra de conductores para entender las acciones del consumidor. Como resultado, se verifica que existe una diferencia notable entre las preferencias actuales de los consumidores de combustible y las preferencias del consumidor percibidas por los actores de la cadena de suministro de etanol. Tal disparidad es, probablemente, una causa más del segundo revés en la cadena de suministro de Brasil (2009-1012). Se destacan las implicaciones estratégicas en la gestión de esta cadena y el papel de las políticas públicas respecto a la mejora de la difusión del etanol en Brasil.

Palabras clave: Opción; Comportamiento del consumidor; Energía; Etanol; Gasolina; Cadena de suministro

Introduction

Brazil has been the pioneer and leader in the deployment of renewable energy, specifically sugarcane-based ethanol. Large-scale diffusion of biofuel in Brazil started forty years ago. The Brazilian government had a decisive role in the launch of the process and provided incentives by implementing the huge production, distribution and retailing infrastructure in this continental country. Many incremental innovations have been introduced in the ethanol supply chain and the consequence has been a steady increase in the ethanol productivity (Goldemberg, Coelho, Nastari, & Lucon, 2004; Van den Wall Bake, Junginger, Faaij, Poot, & Walter, 2009). The automotive industry contributed with innovations such as the ethanol-only engines and, later on, the flex-fuel engines (Furtado, Scandiffio, & Cortez, 2011). These are what we call ethanol fuel technologies. But the diffusion process in this period has had its ups and downs. The first boom started with the introduction of ethanol-only engine in 1979, and around 1985 almost 90% of new cars sold were equipped with these engines. But by the end of 80s the sales of these cars had a dramatic downturn due to wide spread ethanol shortage. We call this the first setback in ethanol diffusion. The last boom period was in 2003–2010 as a result of the astounding success of the flex-fuel vehicles (FFV). However, since 2010, the sales of ethanol have been stagnant compared to gasoline. This can be considered the second setback in the process of ethanol diffusion in Brazil (Alonso-Pippo, Luengo, Alberteris, Pino, & Duvoisin Junior, 2013; Lucas-dos-Santos, 2013; Moreira, Pacca, & Parente, 2014; Salvo & Huse, 2011).

Certainly a mix of all factors mentioned above caused these setbacks. Even though previous studies analyzed consumers' behavior in the refuel of their cars (Aguilar, Cai, Mohebalian, & Thompson, 2015; Van der Kroon, Brouwer, & Van Beukering, 2014) and the viability of the flexible cars in Brazil in a consumer perspective (Samanez, da Rocha Ferreira, do Nascimento, de Almeida Costa, & Bisso, 2014), none investigated the behavior of the consumer. We believe that the consumer behavior preferences can be one of the factors since the sales of ethanol have been stagnant compared to gasoline in 2010 and during this period many FFV owners have been refueling their cars with gasoline instead of ethanol.

Related to ethanol, consumer preferences were studied by Anderson (2012) and Salvo and Huse (2013). Anderson (2012) developed a model to understand the demand for corn-based ethanol of household preferences as a gasoline substitute. According to him, "price responses are considerable smaller" (p.166), however some household are willing to pay a sizeable premium for ethanol. The empirical study in how consumer make choices between gasoline and sugarcane ethanol from Salvo and Huse (2013) has shown that the effect on the price-variation in the gas has a weak effect on consumer choice.

In addition, "consumer demand for gasoline may prove to be sticky" (p. 270).

Thus, this study seeks to contribute to this debate by examining the following questions: how do drivers choose to refuel their cars? Is the perception of supply chain managers about their consumers correct? We aim to investigate whether there is a difference between the actual preferences of fuel consumers and the perceived consumers' preferences by key stakeholders of the ethanol supply chain. The focus of this paper is on the management of the ethanol supply chain in the second setback, more specifically on the role of the Brazilian fuel consumers' preferences. With that in mind, we propose strategies in managing this supply chain and explore public policy implications of it.

Based on a review on the literature of energy technology diffusion and supply chain management, complemented by a sample of pronouncements collected in the Brazilian news media, and on a survey carried out in 2012, with Brazilian fuel consumers, we present the different perceptions between the supply chain's key decision makers and fuel consumers. This disparity may be an important reason of the second setback.

This study contributes to the improvement of ethanol supply chain management through a better understanding of fuel consumer behavior. The analysis of consumers' preferences when choosing between ethanol and gasoline in Brazil has not been explored in the business literature yet. The studies on consumer preferences where focus on price or changing price (Anderson, 2012; Salvo & Huse, 2013). And, the main business researches in ethanol are related to governance structure and gasoline distribution (Soares & Saes, 2015), projection of consumption based in technology or sustainable habits (Silva, Spers, Wright, & Costa, 2013), product distribution (Lopes, da Silva, & Conejero, 2010) and analysis of political strategies (Silva, Caldeira, & Bandeira-de-Mello, 2014). In addition, the majority of papers about ethanol has been focusing on its engineering, economics or environmental aspects, by exploring topics such as alternative biomasses (Wit, Junginger, Lensink, Londo, & Faaij, 2010), public policies (Gonzalez, Berna, & Wetzstein, 2012), ecological impact (Hodbod & Adger, 2014) and financial impacts (Salvo & Huse, 2011).

The following section presents the theoretical basis for the study, the third describes the method of the two studies, the fourth presents the results and discussion and the fifth states the main conclusions.

Theoretical framework

This section presents the literature review of the context described in the introduction: the description to the second setback in the ethanol diffusion and the perception of consumer's preference by ethanol supply chain stakeholders.

The second setback: narrative and perspectives

The development and introduction of flex-fuel engines by companies such as Magneti-Marelli, Bosch and Delphi reignited the Brazilian ethanol supply chain in 2003. The main feature of a flex-fuel engine is the ability to identify the proportion of gasoline or ethanol burned in the combustion chamber, and automatically adjusts the engine's setting accordingly (Nascimento et al., 2009). This feature shifted the consumer's decision from which type of engines to choose, when buying a car, to which fuel type to buy when refueling a car. Therefore, in the refueling moment, it is necessary not only to choose which gas station to go, but also what type of fuel to buy. Government collaborated by granting flex-fuel vehicles (FFVs) the same tax breaks as ethanol-only cars. The sales of FFVs skyrocketed, by 2007 (four years after its introduction), 85% of new car purchases by Brazilians were equipped with flex-fuel engines (Salvo & Huse, 2011). This rate of diffusion of FFVs was higher to that of ethanol-only car more than twenty years earlier. But FFV's diffusion was benefited by other factors: the early 2000s was a period in which the petroleum price was rising; the world sugar price receded compared to that of the 90s; and the extensive infrastructure of ethanol distribution and retail network, built in the 80s, was still operational (Hira & De Oliveira, 2009). The fleet of FFVs, in 2012, represented about 54% of the total licensed light commercial vehicles in Brazil. In absolute numbers, there were approximately 30 million FFVs, the largest fleet of this type in the world (Ministério de Minas e Energias, 2013). This boom also attracted a significant inflow of foreign capital in Brazilian sugarcane industry, and as a consequence the industry went through a frenetic cycle of merges and acquisitions before 2008.

Due to problems related to climatic conditions and the remnants of the 2008 economic crisis, there were strong ethanol price fluctuations in 2009 due to tight supply. Too much rain during harvesting lowered the saccharose content, thus less ethanol per ton of sugarcane. The 2008 financial crisis created operational difficulties for sugarcane mills. Many of them had liquidity problem to finance their operations. In order to save cash, numerous plantations delayed the reform (replant) of sugarcane plants and therefore jeopardized future ethanol productivity. The economic crisis also decelerated many planned ethanol production capacity expansions. In 2010 the ethanol sales suffered its first decline in seven years. The numbers worsened in 2011, when price spikes brought down the sale of ethanol (Lucas-dos-Santos, 2013). According to the Brazilian government, in 2011, the consumption of ethanol reduced 7.7%, while the gasoline increased 17.4% in the same year (Mines and Energy Ministry, 2012). It was clear that even though the number of Brazilian flex-fuel car was increasing, these car owners were opting for gasoline in refueling times. The turmoil in the ethanol market prompted Brazilian government to intervene in 2011: the president Rousseff ordered the ANP (National Agency for Petroleum, Natural Gas and Biofuel) to monitor and oversee the ethanol production and distribution network. However, the market reaction had been sluggish, the ethanol consumption of 2012 and 2013 were still below that of 2011 (Lucas-dos-Santos, 2013).

The above brief description captures the main events leading to the second setback. However, in order to understand these events, we need a conceptual framework. We propose two frameworks to shed lights for this paper. They are complementary; the first is the literature on energy technology diffusion and

transition. This is a long-term view on the process of adopting a new energy technology (Fouquet, 2010). The second framework is that of supply chain management. This framework takes a more operational view of achieving the desired performance of a supply chain.

The literature on diffusion of new energy technologies or energy transition has contributed to our understanding of barriers to the adoption of these innovations. These new technologies, even after first successful commercial application, can face many barriers such as operational inefficiency, infrastructure needs, information and financing constrains to achieve a widespread diffusion. The complexity involved in these transitions has also been pointed out as one important barrier. In order to surmount these barriers, an effective strategy of learning-by-doing is critical (Markard & Truffer, 2008; Sagar & Van der Zwaan, 2006). The deployment of a new set of technology usually encounters unexpected obstacles, thus the ability of learning from setbacks is crucial for the success of diffusion. Learning provides feedbacks to improve the performances of new energy technologies through cost reduction, operational proficiency, as well as institutional mutations so as to facilitate adoption (Sagar & Van der Zwaan, 2006). The diffusion of fuel ethanol in Brazil, object of this study, one of the first large scale implementation of biofuel in the World, had benefitted significantly with incremental innovations and improved coordination, through mostly learning-by-doing, during these forty years of diffusion (Goldemberg et al., 2004; Van den Wall Bake et al., 2009).

In a more general discussion about managing transition in large technical systems, such as the transportation system, Geels (2004) also observed the importance in understanding the diffusion and use of technology. He argues that policy makers must pay attention to both innovation process and users so that we can better manage transitions. In adopting a new technology, such as the FFV, consumers have to incorporate it into their dairy routines which, depending on the characteristics of the new technology, may involve significant learning and adjustments. Through learning-by-adopting, consumers can better articulate their own preferences and discover new functionalities. This articulation of new consumers' preference may take years, since "it occurs in small incremental steps, and often involves experiments and setbacks" (Geels, 2004, p. 908). On the other side, for those firms that introduced new technologies in the market place, the challenges are to understand, first, who are the consumers, and second, to monitor their changing preference during diffusion. Mismatch between consumers' preference and the perception of it by the producers can lead to tensions and retard the diffusion of the new technology (Geels, 2004).

The second framework is based on the supply chain management literature. Chopra and Meindl (2013) defined that a supply chain consists of all stages involved, directly or indirectly, in fulfilling a customer request. In the Brazilian ethanol supply chain the main stages are: sugarcane plantations, mills, storage sites, transport systems, gas stations and respective suppliers. In fulfilling customers' requests, a typical supply chain's performances can be characterized by two major dimensions: efficiency and responsiveness. To improve these performance measures a supply chain has to make better decisions in four basic strategic areas: transport, inventory, facility (ethanol mills) and information. All these decisions involve trade-offs between efficiency (costs) and responsiveness. Transport by ship is low in cost but slow in responsiveness. Higher ethanol stockpile costs more but can improve responsiveness. Large centralized inventory provides scale economy but may result in longer lead-time. Most important of all is the ability to coordinate actions of supply chain partners through information. A better coordinated supply chain can avoid excess of some products and shortage of others by improving the ability to predict demand. Moreover, a well synchronized supply chain can avoid damaging instabilities such as the bull-whip effect (Croson, Donohue, Katok, & Sterman, 2014).

In order to boost a supply chain's performance, the literature suggests that the fundamental first step is a thorough understanding of the nature of demand (Fisher, 1997). In the case of a product with a stable and predictable demand, a more efficient supply chain, with lower production, transportation and storage costs, should be adopted. In the case of an innovative product, such as the FFV, both demand and supply of ethanol can be uncertain and difficulty to predict, therefore a more responsive (fast and flexible) supply chain is called for (Lee, 2004).

We now employ these two frameworks to analyze the setbacks described above. From the perspective of energy technology diffusion and transition literature these setbacks were not abnormal phenomenon. Many barriers, technical, economic and social, are scattered on the road of transition or diffusion. Our analysis of these setbacks shows that the main barrier in the Brazilian transition had been the periodic mismatches between ethanol supply and demand, which caused price oscillations or shortage. Besides the natural variation of supply between the sugarcane harvest season and off-season (in the Brazilian Center-South Region harvest goes from April to December), there had been other causes: higher international sugar prices decreased the amount of sugarcane devoted for ethanol production; lower prices of petroleum squeezed the profit of ethanol producers, since ethanol price should be 30% less due to its lower energy density; demand surges with the success of innovation such as FFVs; and relative long lead time to expand ethanol production capacity. These and other events combined had produced mismatches between supply and demand, generated price oscillations such as that of 2009 with negative impacts on the sale of ethanol afterwards.

Brazilian supply chain key stakeholders, including policy makers and company executives, have taken many measures to tame these mismatches in these years. Examples were government's restrictions on ethanol exports in several episodes of strong domestic demand and tight supply; introduction of many incremental innovations in every stages of the supply chain with significant ethanol cost reduction; and, after government deregulations at the second half of 90s, producers of sugarcane, sugar and ethanol established the Sugarcane, Sugar and Ethanol Producers' Council (CONSECANA) in order to coordinate the supply chain.

These measures were taken as attempts to improve the ethanol supply chain performance (prevent further mismatches). However, as we described earlier, these measures had not been able

to avoid the second setback. In this paper, instead of discussing the challenges in managing these mismatches, we propose to explore a couple more fundamental questions (based on the recommendations of two frameworks previously discussed): first, what had been the presumed consumers' preference espoused by key stakeholders (policy makers and others relevant decision makers) in Brazilian ethanol supply chain? Secondly, what were the Brazilian fuel consumers' actual preferences? The first question is relevant because the decision maker's frame of mind strongly influences the selection of supply chain strategy. Differences between the presumed and the actual consumers' preferences would indicate a problem in managing ethanol supply chain: not fulfilling customers' demand. The importance of the second question has been emphasized by both energy technology diffusion and supply chain management literatures. A better understanding of the demand and the customers' preference should determine the supply chain strategy. In other words, the customers' preferences should steer a supply chain to be more cost efficient or to be more responsive. As a matter of fact, at the heart of both setbacks was the consumers' decision not to purchase the ethanol-only cars (in the 90s) or ethanol for their FFVs (from 2010 onward). The fleeing of consumers away from ethanol suggested that the ethanol supply chain was not fulfilling customers' requests.

The first question is discussed below, the second question is the topic for an empirical study presented in the third section, and resulting consequences for governmental policy and strategic management of ethanol supply chain are discussed in fourth and fifth sections.

Presumed consumers' preferences espoused by policy makers

As mentioned in the previous section, in discussing the first question, what had been the presumed consumers' preference espoused by key stakeholders, we present pronouncements of key stakeholders, including government officials and supply chain executives, since 2005 (right after the surge of FFV sales). Our data come from a survey of Brazilians magazines and newspapers from 2005 to 2012. We collected around 30 articles that illustrate key stakeholders view of consumers' preferences. We opted to describe selected statements that reflect the key stakeholders' mindset, and these influences in the decision-making.

The first set of the selected statements praises the working of the market. For example the Director of the Department of Sugarcane and Bioenergy, Agricultural Ministry, said during the initial surge of FFV sales in 2005: "*. . .(with FFV) consumers would adjust the price of ethanol by choosing the type of fuel. . .*".

As the representative of ethanol producers, the president of Brazilian Sugarcane Industry Association (Unica) made the following remarks in 2006: "*Price (of ethanol) is defined by the market; it "s a question of supply and demand*".

In 2010, when the ethanol sales suffered its first decline in seven years, the new president of Unica, an economist by training, made the following comment: "*. . .we can say that today's ethanol market is an example of the correct working of the market forces. The market adjusts the ethanol price. FFV is the enabling technology which permits the consumer to choose the fuel depending on the relative prices.*"

Based on this kind of statements, we can infer that the mind-set of Brazilian government and ethanol industrial decision makers were based on the economic theory of demand and supply. In other words, in the period after 2003 when the FFV became widely available, they have implicitly presumed that the preference of Brazilian consumers is only for a lower fuel price: they will buy ethanol if it is economically to do so. Their rationale is that Brazilian consumers would not care about the price oscillation of ethanol, since with the FFV the consumer can take advantage of these oscillations. Put it in another way, they regarded Brazilian flex-fuel vehicle owners as economically rational decision makers (Salvo & Huse, 2011). Indeed, studies have shown that a truly rational Brazilian flex-fuel car owner, a practitioner of real options, can gain significantly with these price oscillations (Camargo et al., 2011). Therefore, it is expected that these stakeholders would push for a more efficient supply chain strategy instead of a more responsive one.

In 2009 the symptom of a crisis was already apparent to many insiders in the ethanol supply chain. This was reflected in a 2009 report by the agency of the Agricultural Ministry that regulates farm production and distribution (CONAB) alerting that: "*. . .Brazilian ethanol consumers are not used to its price oscillations, compared with the stable prices of gasoline (controlled by the Government). . . and these oscillations can turn consumers against ethanol. . .*".

So, consumers were comparing price dynamics of ethanol against that of gasoline. A local newspaper interviewed common people on the street in 2011 and reported the following sentiments of ethanol consumers: "*There is no justification for these price increases. . . This is a robbery*".

In the same year, even a director of Unica acknowledged the negative reactions of consumer and stated that: "*. . .(ethanol) consumers are irritated by these price oscillations*".

These statements show that, starting around 2009, there have been voices warning that the ethanol industry should be concerned with the responsiveness of ethanol supply chain. They have noted that consumers have not been so tolerant with the large price oscillations. Producers began to understand that the biofuel market is different from the sugar market (Balat & Balat, 2009). In the sugar market the price oscillations do not bother so much the consumers (Anderson, 2012; Salvo & Huse, 2013), but since the costs of fuel are a significant fraction of average consumers' income, sudden ethanol price hikes are not welcomed and can stain the image of biofuel in the long run.

The above statements by key stakeholders and newspaper reports suggest the existence of a gap between the actual consumers' preferences and the presumed preferences, by these key stakeholders, with regard to ethanol. Because of that, we conducted an empirical study of Brazilian FFV owners' actual preferences in fuel selection in 2012 as will be presented in the next section.

Understanding consumers preference – empirical studies

We conducted two empirical studies. The first one was qualitative which sought to explore a topic and discover and identify patterns, including exceptions to the rules related to how individuals (Malhotra, 2011), who have FFVs, choose the type of fuel. For that, interviews which allows to gather rich data from consumers and focus on the subject (Myers, 2013) was employed. Thus, this first study was a very exploratory research. The second study complements the first. Using information from the first study, a survey was created. A structured questionnaire allows researchers to describe the characteristics of the relevant group, such as consumers. Also, it allows statistical inferences and minimize sample errors (Malhotra, 2011). Since the aim of this paper was to better understand the fuel demand, the quantitative research permits by a numerical representation describe and explain (Malhotra, 2011) the factors that affect how consumers choose the fuel. In addition, the survey enables not only to describe the drivers for choosing the fuel, but also to make comparison between groups, observing consumer's segments.

Study one: Qualitative research

To perform the qualitative research, we conducted fourteen in-depth interviews, all of them done in São Paulo state. All interviewees had to have a flex-fuel vehicle and had to be responsible for it. The script was done with the idea of understand how consumers choose the energy. So, first, the respondents stated the last time they fueled their cars, explaining how they chose the gas station and fuel type, and their reasons for their choice. We opted to ask interviewees how they chose their fuel last time to ensure more detailed information and avoid false memories. Then, specific questions were added to improve the information of consumer's preferences. For instance, at the end of the interview, the participants showed how their belief on how other individuals make these decisions. The semi-structure question guide was defined based on Salvo and Huse (2011) study and they were reviewed by two experts in the area of decision-making. The structured questions used in the study is presented on Appendix A.

Study one: Analysis and results

We interviewed 14 people from São Paulo state who had flex cars. All of them were recorded and transcribed. On average, the interviews lasted 25 min.

To analyze the data, we used content analysis. This technique is widely used in qualitative research, and help researchers to summarize content/text (e.g. documents, oral communication). The conventional content analysis permits a replicable and valid inferences by interpreting the textual material. So for this study, we coded the data, using sentences that could label sentences or paragraph. Then, we identify themes trying to organize the information. The third step was to identify themes, concepts or behavior that linked each other (Myers, 2013). After that, we identified four main categories: purposes for using car, when to refuel, choosing fuel, and choosing gas station. Our focus is on the fourth category, but the other three provide context to understand consumers' behavior, so they are also described.

Table 1
Interviewees.

ID	Gender	Marital status	Brand	Model	Year
1	Male	Married	Renaud	Sandero	2009
2	Male	Married	Ford	Ka	2010
3	Female	Married	Volkswagen	Gol	2008
4	Male	Married	Ford	Fiesta	2006
5	Male	Single	Ford	Fiesta	2007
6	Male	Single	Citroen	C3	2010/2011
7	Male	Single	GM	Montana	2009
8	Male	Divorced	Ford	Ka	2008/2009
9	Female	Widow	Volkswagen	Fox	2011
10	Female	Single	Honda	Civic	2009/2010
11	Female	Divorced	Citroen	C4	2008
12	Male	Single	Fiat	Uno	2006
13	Male	Single	Ford	Fiest	2009
14	Female	Single	Fiat	Palio	2006

Table 1 presents the interviewees descriptions.

Following, we describe the results adding some citations from our interviews.

Purposes for using car – Drivers use their cars for different reasons. Some use them only to transport themselves from their homes to work or school: "*I use it to go to my office and school*", "*To transport myself to work and university*". Others work with the car: "*Sometimes I use it to visit customers and bring something to them*". A third group used them mostly during weekends or for traveling: "*For leisure, or when I have to do something far from my home, most of the time the car stays at garage. I am opting for public transportation*"; "*Twice a week I use it to go to work, but nowadays I am using more bus. So I use the car more on the weekend for sightseeing*".

Refueling time – According to how customer use their cars they have a different behavior in where and when to refuel their tanks. We have one group that plan their refueling: "*I was going to travel, even though I still had ½ tank, I decided to refuel because the gas in the city is cheaper*"; another who never wait for the "low fuel" light to turn-on; a third group prefer to refuel only when the "low fuel" light is on: "*I usually refuel when the light is on, in this case if I find the gas station not so reliable, I do not completely refuel the tank*".

Choosing gas station – One of the most common reasons in why people chose the gas station was the price. But the trust in the brand was also relevant: "*Of course there are some gas stations with very cheap fuels, but I distrust*", "*I always try to refuel in gas stations that I know, at least the brand name*", "*I chose by the brand name*", "*I chose by the quality of the fuel. I prefer to refuel always on the same gas station*". The convenience was also commented: "*I used to go to a gas station that washed my car for free when I spent more than R$20*"; "*I like to go to gas station which clean my windows or calibrate the tires*"; "*The service is something that counts; I like when they check the water tank and the oil*". Among the customers there are those who prefer gas station close to their work, or on the way to their homes, others prefer to drive a little bit more to a cheaper one,

Table 2
Total variance explained.

Factors	Eigenvalues	% of variance	Cumulative %	Cronbach's Alpha
1	6.348	28.854	28.854	0.913
2	3.327	15.121	43.975	0.746
3	1.741	7.916	51.89	0.577
4	1.182	5.371	57.261	0.651
5	1.07	4.865	62.126	0.670

and some do not care about the price and uses the one that is on the way.

Choosing Fuel – The reasons for choosing the kind of fuel are various, the most cited is the price: "*Of course we think about the quality but I always search for a better price*"; "*When my cash is low, I buy ethanol since it is cheaper although I know I will need to refuel again soon*"; "*The rule is the one that everybody knows: the price of alcohol should be 70%, or less, of the price of gasoline*"; "*When the ethanol was cheaper, I used to mix the fuel*". On the other hand, there are the ones that do not care about the price: "*Do you think I know how much I paid for the fuel?*" Another common motive is the convenience: "*The fact of not having to stopping all the time in the gas station, I find it [gasoline] an advantage*". Environmental concern was also commented: "*Ethanol has the advantage to pollute less, then if you drive to the city it is even better*"; "*If it is not too expensive, I prefer to refuel with ethanol since it is more sustainable*". The question of quality was also present in the interviews: "*Many people talk about the price but the quality of fuel is important*". There is also some believes such as "The car is flex and I know that if I put only gasoline, or put only ethanol, it does not influence the car's engine, but once in a while I find it is important to change the fuel"; "*My car is having a problem in the piston, and the alcohol can clean it*"; "*When I refuel the tank with ethanol the car does not work very well, for instance in the morning it is difficult to start*"; and "*The gasoline is more trustful*".

Observe that in choosing fuel categories, using the idea of most cited motives or argument for choosing the product, it was possible to define subcategories such as: price, convenience, environmental concerns, quality and, believes. Based on these specific category (choosing fuel), subcategories, and consumers statements, we opted to do a new empirical study presented in the next section.

Study two: Quantitative research

In order to understand how consumer chose the fuel types, we carried out a quantitative research through a questionnaire survey, which was aimed to identify the main factors of these choices. Guided by the information gathered from the qualitative research and by the key stakeholder's pronouncements, we developed statements, which were the basis for this quantitative survey.

Brazilian drivers, from São Paulo, received the questionnaire by email. Qualtrics software was used to the online distribution. The method of "snowballing" was used, allowing the individuals who received the questionnaire to resend the link to their acquaintances, thereby increasing the sample and distributing the survey to various segments of individuals. Before participants started, they read a consent form and the instructions of the study. The participants did not receive money, it was just explained that the study was been done by researchers from their universities and it was important their participation on the study. The first question they had to answer was whether or not they had a flex-fuel vehicle and if they were responsible for the car. Only participants, who were approved in the filter, could answer the questionnaire for this research. It would not make sense for people, who do not own a flex-fuel car, to participate in this study.

After the filter, the participants were asked to indicate the extent to which they agreed or disagreed with each statements. These sentences were measured on a five points Likert scale (1 = completely disagree and 5 = completely agree). The sentences were randomly arranged among participants. Participants completed 22 statements and some demographic questions.

It is important to comment that the present empiric study was carried out at the end of 2012 just after the second set back. The next section presents the results of this study.

Study two: Analysis and results

In order to identify the factors that influence the choice between buying ethanol or gasoline, we applied the online questionnaire and then we analyzed using exploratory factor analysis. The factor analysis is a statistic method used to identify relationship between measured variables and is it also a variable reduction technique. In other words, it is used to explore the underlying factor structure of a set of observed variables (Malhotra, 2011), in this paper cases the factors that can be influencing consumers fuel choice.

We received 232 questionnaires, excluding the incomplete ones, we had a total of 209 forms. Of these, 122 individuals were men, representing 58.4% of the sample. Regarding their marital status, 46.4% were married, 9.1% were living with their girl/boyfriend, while 38.3% were single. In terms of their education, 24.9% had a Master or Doctorate degree, 29.7% had college-level qualifications, 27.3% hadn't completed college and 15.3% had high school qualifications. The majority of participants were aged 30–39 years (40%), while 61 (29%) were between 20 and 29 years old, 38 (18%) were between 40 and 49 years, and 25 (12%) were over 50 years old. None of the participants were below 19 years old. By law, drivers must be over 18 years old, in Brazil. Participants pointed out which fuel type they usually prefer to supply the car, as a result 50.7% fueled with gasoline, 29.7% with ethanol and 19.6% have no preference between ethanol or gasoline.

We conducted an exploratory factor analysis (EFA) with *Varimax Rotation*, using the Factor Eigenvalues (greater than 1) to establish the number of factors. To verify the adequacy of the sample, we measured the Kaiser-Meyer-Olkin (KMO) and the Bartlett test of sphericity. To verify the internal consistence of the factors, we conducted the Cronbach's alpha test for each factor found. Factors with Cronbach's alpha above 0.70 are acceptable

as an indicator of internal consistence (Hosmer, Lemeshow, & Sturdivant, 2013).

The EFA resulted in five factors, which explained 62.1% of the variance. The Bartlett test of sphericity confirmed the suitability of performing factor analysis ($p < 0.001$) and the KMO was 0.873, considered appropriate according to Hosmer et al. (2013).

Table 2 presents the five factors obtained from the final analysis, including the Eigenvalues, the percentage of variance explained by each factor and the Cronbach's alpha results.

According to Hosmer et al. (2013) the factor loadings should be above 0.50 in samples with approximately 200 subjects. Thus, we took out the factors with loadings smaller than it. The MSA (Measure of Sampling Adequacy) was appropriated to all the variable factor analysis, except for one item "The fuel quality is more valuable than the price" that was excluded to the analysis. One possible explanation of why this statement had a low loading could be the mix of information quality and price; where some participants believe that the quality is more important than price, but other prefer price because may perceive gasoline the same everywhere. In Table 3, the 22 statements are presented together with factor loadings of each item.

The first factor, which was renamed 'convenience', has 9 items and explains 28.85% of the variance. This factor shows that individuals prefer to buy fuel that has a longer range; i.e., they prefer to minimize their journeys to gas stations. The choice of fuel that minimizes the need to come back to the gas station is also evident in situations where individuals will drive longer, for instance when they have to do long trips by car.

The second factor renamed 'clean fuel' has 4 items, which explain 15.12% of the variance. This factor shows individuals concerned with sustainability, seeking to refuel with ethanol, which is considered as a clean fuel. In some cases, participants opt for this clean fuel, simply because they are against the gasoline. Although it is not their preference, they believe that the ethanol fuel has additional environmental benefits.

The third factor, 'economics', has 3 items, which explain 7.92% of the variance. This factor shows that individuals seek to be rational in their choices, seeking to acquire the most cost-effective fuel. It shows that individuals calculate to find out if the price of gasoline is 0.7 times the price of ethanol. This is an easy calculation that people usually compute to verify which fuel is cheaper.

The fourth factor, 'trust', has only 2 items, which explain 5.37% of the variance. This factor represents the amount of trust that individuals have in the fuel type; their ideas on this factor relate to the perceived performance of their vehicles.

The fifth factor was renamed as the pursuit of 'beliefs and influences' and it had 2 items, which explain 4.87% of the variance. This factor includes the term influence because it shows that other individuals may also interfere in the processes of consumer's fuel choices. Information or other individuals can influence a consumer's choice of fuel type.

Once identified the most important factors that intervenes in the consumers' choice, next section presents the analysis of the impact of these factor on the probability of choosing ethanol or gasoline.

Impact factor in choice of fuel

In order to calculate the impact of each factor on the probability of choice of fuel type, we ran two multinomial logit econometric models where the dependent variable was the

Table 3
Matrix of rotated components: dimensions and factor loadings.

	Factors				
	1	2	3	4	5
I refuel with gasoline, even when it is a bit more expensive because it reduces the number of times I have to refuel.	0.873				
I always refuel with gasoline, so that I do not need to regularly go to the gas station.	0.843				
I choose to fill up with gasoline because it is convenient.	0.773				
Regardless of how much I am going running, I refuel with gasoline.	0.753				
I prefer fuels that last longer, so I can drive over.	0.746				
I always refuel with gasoline, because I am used to this fuel.	0.743				
The time spent going to the gas station, makes me prefer to refuel with gasoline.	0.742				
I like my car a lot, so I use gasoline instead of ethanol.	0.639				
If I will travel by car, I do not want to stop at gas stations along the way, so I refuel with gasoline.	0.566				
In cities with high levels of pollution, it is crucial to worry about air quality. So I opt to refuel with ethanol.		0.782			
Ethanol is a greener fuel and hence it's my fuel of choice.		0.756			
Even if ethanol is a bit more expensive, I opt for this fuel because it helps the environment.		0.665			
I refuel with ethanol only in gas stations that I trust.		0.627			
I always do the math: the price of gasoline must be 70% greater than that of ethanol for me to refuel with ethanol.			0.744		
Based on a head calculation, after knowing the gasoline price, I decide what the best fuel to buy is.			0.725		
When ethanol is cheap, I completely fill the tank with it.			0.689		
When I do not trust the gas station, I choose gasoline instead of ethanol, because of adulteration risk of ethanol.				0.759	
When I do not trust the gas station, I refuel with ethanol instead of gasoline, because of adulteration risk of gasoline.				0.746	
I refuel with ethanol because it keeps the piston clean and without trouble.					0.748
If I park my car besides a pump with ethanol only, I do not dumb to refuel with gasoline.					0.641
I prefer to use ethanol because I think my car runs better with this fuel type.					0.525

Table 4
Model base in the ethanol choice.

	Ethanol – gasoline			Ethanol – mixed		
	Coefficient	Standard deviation	Significance	Coefficient	Standard deviation	Significance
Constant	1.238	0.284	0.000*	0.262	0.328	0.425
Convenience	2.547	0.389	0.000*	1.131	0.367	0.002*
Clean fuel	−1.138	0.270	0.000*	−0.975	0.260	0.000*
Economics	−0.230	0.286	0.422	0.423	0.298	0.156
Confidence	0.789	0.263	0.003*	0.022	0.257	0.932
Beliefs	−1.644	0.306	0.000*	−0.668	0.273	0.014*

LR statistic = 144.47 ($p < 0.00$).
Note: *The significance threshold was set at .05.

chosen fuel and the independent variables were the scores of the five factors identified in the previous section. We run the regression analysis using SPSS. The factor scores are measures of each factor attributed to the observations. Hosmer et al. (2013) state that scores are measures that can be used for further analysis using factor analysis to represent all variables with the corresponding factor loads.

We used the regression model described:

Fuel: $j = 0$ – Ethanol, 1 – Gas, 2 – Mix.

Subjects: $i = 1, 2, \ldots, 216$.

Factors: $p = 1, 2, 3, 4, 5$.

Linear estimator of subject i: $X_i\beta_j$

Probability of the Individual i chose the fuel j:

$$Pr(Y_i = j) = P_{ij} = \frac{\exp(X_i\beta_j)}{1 + \sum_{k=0}^{j} \exp(X_i\beta_k)}$$

The estimated model was globally valid because the statistical maximum likelihood (LR statistic) was significant as presented in Table 4. The R^2 of McFadden indicates that the model has a good fit (0.337). The choice of ethanol is the omitted variable so that all results should be analyzed with respect to this choice. To verify if there were limitations to logistic regression, we performed a crosstabs analysis and there were no restrictions on the goodness-of-fit regarding the use of the model. We run the SPSS NOMREG instruction and the results show no serious violation of the assumption of linearity of the logit.

The results show that the convenience factor increased the probability that the consumer chooses gasoline first and as a second option chose the mixed fuel (ethanol and gasoline together). Contrary to this result, the appeal of clean fuel reduced the likelihood of gasoline choice and mixed fuel respectively. For this sample, the economics factor was not a significant factor in the choice of the two fuel types; in other words, participants seems not to worry with the price during their choice. However, the negative beta shows that if the ethanol is high there is a tendency of consumers prefers gasoline. The confidence factor increased the likelihood of exclusively choosing gasoline, but it was not significant for mixed fuel. On the other hand, the belief factor reduced the probability of choosing gasoline and mixed fuel respectively. In the next section, we present some extra analysis related to demographic differences between subjects.

Table 5
Comparing genders.

	Anova test		Average score	
	F	Sig.	Male	Female
Convenience	5.051	0.026*	2545	2853
Clean fuel	0.241	0.624	2709	2770
Economics	6.339	0.013*	2213	2510
Confidence	0.656	0.419	3467	3353
Beliefs	8.979	0.003*	2332	2516

Note: *The significance threshold was set at .05.

Demographic differences

We analyzed various demographic questions and found that gender interferes with the process of choosing fuel. We run an ANOVA with the intention to check for differences in choices of fuel type between men and women. Before performing the ANOVA, the Levene's test was performed. For all factors, the p values were lower than 0.10, which confirmed the suitability of using ANOVA.

We found a statistically significant difference (p-value < 0.05) between genders in the factors convenience, economics and beliefs. Table 5 shows the means for men and women of all the fuel choice factors. It can be observed that in the three factors mentioned (convenience, economics and beliefs), women had significantly higher mean scores than men. The findings of the research on the issue of convenience are consistent; women prefer or value convenience in both their choice of gas stations and as well as fuel type.

Discussion

In this section, first we present a summary of the results, then we discuss these findings based on the frameworks of energy technology diffusion/transition and supply chain management previously presented in the theoretical background, with the purpose to explore possible causes of the second setback in Brazilian ethanol industry.

With the technology of flex fuel engine, more consumers had to choose between or the proportion of gasoline or ethanol (Nascimento et al., 2009) during a cars refuel. With that, a new challenged appeared to the supply chain management: understand the consumer's preferences and perceptions (Geels, 2004). According to Fisher this is a fundamental step to understand

the nature of demand (Fisher, 1997). Based on that, using an exploratory study we explored motives in how consumers act and think about refueling their cars. With deep interview, four main categories related to flex cars owner perspectives were formed: the purpose of using car, the period or reasons for being refueling the car, the motives for choosing one type of fuel against other and the process of choosing the gas station. Among these categories it was possible to observe subcategories such as economic perspective or convenience being in agreement with Salvo and Huse (2013) idea. So, a second empirical study was run to define the real drivers that influence consumer choice. Using statements developed by the interviews, into the motives for choosing a fuel category, statements were presented in a questionnaire to flex owner cars. As a result, five drivers were uncovered: convenience, clean fuel, economics, trust and beliefs. Knowing consumer's behavior, we were able to run a logit regression that showed that the economics driver was not influencing consumer's choice. That means Brazilian flex-fuel vehicle owners seems not to make economically rational decision as commented by a few researchers (e.g. Salvo & Huse, 2011), and in opposite perspective to mind-set of Brazilian government and ethanol industrial (e.g. UNICA comments on media).

With these results, our research has revealed that another probable cause of the second setback, among many already commented by other researchers, usually related to supply chain (Alonso-Pippo et al., 2013) was an incorrect perception of fuel consumers' preferences by key stakeholders. In our survey, FFV owners considered factors such as Convenience and Clean Fuel as more relevant than Price in choosing between ethanol or gasoline. However, the second setback demonstrated clearly that large price hikes can undermine the dominance of other factors in consumers' decision. On the other hand, the statements by key stakeholders indicate that in the initial phase of diffusion of FFV, these stakeholders believed that FFV technology had empowered car owners to choose the more economical fuel. FFV car owners would not be locked-in as with the ethanol-only car owners of the 80s/90s. They assumed that these consumers could gain much economically by rationally choosing the right fuel. Therefore, the ethanol supply chain did not have to be concerned with the price oscillations since, as mills owners argued, these are natural phenomenon for an agricultural product. As a result of this believe, strategic ethanol stockpile has not been implemented, even though it has been discussed in many occasions by the ethanol supply chain's decision makers and there is storage capacity in the ethanol supply chain (Lucas-dos-Santos, 2013). As a consequence, the occurrence of violent ethanol price oscillations in 2009 and 2010 that caused a three years consecutive decline of ethanol consumption (during this period the consumption of gasoline had significant gains) and maybe that is why in 2012, when our data was collected, FFV owners considered the Price not so relevant. Our hypothesis is that these FFV owners had settled into a routine by purchasing gasoline after 2009. Our results are notable because they show that consumers are not only concerned with economic issues but also with other issues such as reliability, convenience, sustainability and beliefs. Therefore, understanding consumers' preference could better prepare managing ethanol supply chain and potentially avoid the setback.

Our survey identified attributes that are relevant for FFV owners in fuel selection. Note that the ethanol supply chain can only start to discuss how to deal with a problem if it recognizes the problem. Supply chain factors are those that the supply chain management has more control over such as economics (more specifically the production and distribution costs, thus the price), convenience (specifically the FFV range), and environmental sustainability. In order to improve the market share of ethanol, the ethanol supply chain should exploit these factors that it can control such as lower ethanol price, improving convenience, highlighting the environmental sustainability. In the following paragraphs we offer suggestions, based on our research results, for strategy management of Brazilian ethanol supply chain and for public policy related to ethanol regulation.

With regard to the ethanol price, the ethanol supply chain has been successful in reducing ethanol production and distribution costs through incremental innovations in the last forty years, but not so in decreasing the amplitude of ethanol price variations. The investment to reduce price oscillation (e.g., strategic stockpile of ethanol) required can be quite large, but it should be justified with the possible loss of revenue for the ethanol supply chain if another setback occurs.

Another way to deal with the problem of ethanol price oscillation is to look at the competing gasoline supply chain. One of the problems with the ethanol price oscillation is that the competing product, gasoline, has a stable price maintained by government. The Brazilian government's aim was to control the inflation. However, this policy has created an uneven playing field against ethanol. This is more serious due to the existence of natural seasonal price oscillation of ethanol due to its production cycle which does not occurred with gasoline.

Along with the economic factor, another top ethanol supply chain related factor for FFV owners is the convenience. By using ethanol, the refueling frequency is higher due to its lower energy density. This is inconvenient for FFV owners. One solution to improve the convenience is to increase the engine efficiency, when burning ethanol, as we have already mentioned. This solution implies that the ethanol supply chain should have an active participation in the development of future ethanol consuming technologies, for example, sponsoring research programs in developing improved ethanol internal combustion engines for hybrid electric cars. Another solution is to influence the perception of the FFV owners with regard to the "inconvenience" of refueling with ethanol. Many other service sectors employ techniques to reduce the inconvenience perceived by clients. A classic case is that the perception of waiting time in a queue can be influenced by some entertainments such watching TV (Thomke, 2003). Brazilian ethanol supply chain management can certainly learn from these experiences in managing clients' perceptions in order to improve its competitiveness with the gasoline supply chain.

The third ethanol supply chain specific factor is the fuel's environmental sustainability. In our survey, the perception of FFV owners is favorable to ethanol in terms of its environmental sustainability. Thus the ethanol supply chain should reinforce

this perception through its communication with the public. In consumer decision making the issue of trade-off is a traditional theme in marketing literature since it documents the positive relationship between price and perceptions of quality. Price and quality tend to be seen as a trade-off that requires relinquishing something (convenience) for something else (environmental sustainability).

Our survey indicates that there are different segments of FFV owners, for instance the different choice behavior between genders. Female FFV owners rate convenience more important than men in choosing fuel. This result corroborates the idea of Dommeyer and Gross (2003) who argue that gender should be considered as a key variable in studies of consumer behavior. A segmented marketing strategy should be employed by the ethanol supply chain to manage the communication with different segments of ethanol consumers. In addition, the ethanol supply chain should have quantitative measures of trade-offs between price and environmental sustainability for FFV owners in different segments. These data can also be relevant in making ethanol supply chain strategic decisions. For instance, in deciding on how much to invest in ethanol stockpiling capacity, the ethanol supply chain needs to have an estimate of the amount of additional ethanol revenue with a given price reduction provided by stockpile.

Finally, all the implications discussed above require that the Brazilian ethanol supply chain be able to: first, make strategic decisions based on these implications, and second, implement them in a timely and coordinated way. This has to do with the governance of the ethanol supply chain. Based on what happened in the last setback, this governance of, or coordination in, the Brazilian ethanol supply chain is still not mature if we compare with that of gasoline supply chain (Lucas-dos-Santos, 2013). Using the language of supply chain management (Lee, 2004), the Brazilian ethanol supply chain should be a faster learner as a mean to be more adaptable to a dynamic context.

Conclusions

The main research questions of this paper are: first, how do drivers choose fuels in refueling time? Second, is the perception of ethanol supply chain managers about their consumers correct? These are the key questions to be answered in order to understand possible causes of the set-backs in Brazilian ethanol supply chain. Our results show that there was a significant difference between the actual preferences of fuel consumers and the perceived consumers' preferences by key stakeholders in the last setback of the Brazilian ethanol supply chain. Based on the literatures of energy technology diffusion/transition, and supply chain management, we explore the implications of this difference on government policy and ethanol industry's supply chain strategy. Our research method is based on a literature review on the events occurred before and during the second set-back in order to identify the supply chain key stakeholders' perceptions of consumers' preferences, plus a qualitative and a quantitative study on Brazilian fuel consumer preferences.

This paper contributes to the extant research in clean fuel diffusion by showing the relevance of consumers' preference in coordinating an emerging ethanol supply chain which incorporates some significant technological innovations in the last few decades. Another contribution of this paper is the integration of the theories of energy technology diffusion/transition and supply chain management in order to understand the role of consumers' preferences in the ethanol industry's performance and its implications on public policy.

We agreed with Collantes (2010) that public policies should contain a value proposition more robust than just the economic incentives to encourage ethanol consumption. With our results, the first consequence for the ethanol supply chain management is the need to have a system to monitor and foresee car users' preference. This monitoring should be periodic so the ethanol supply chain can trace the changing mood of consumers of ethanol, identify the correct causes and take appropriate actions to mitigate possible negative impacts. We believe that conventional marketing research techniques can be employed for this purpose. In particular, the ethanol supply chain should paid special attention to technological innovation's impact on car owners' routine. In the two setbacks in Brazilian ethanol supply chain discussed in this paper, we observed that both occurred after a demand boom caused by a new ethanol consuming technology and subsequent ethanol supply bottleneck. Therefore, the ethanol supply chain should monitor new ethanol consuming technologies that can up-set car owners' ethanol purchase routine, and should assess the possible implications for the ethanol supply chain and then recommend adaptations of the ethanol supply chain to the new technology. Several ethanol consuming innovations are in the development stage and all of them can affect car owners' purchasing routine. A more efficient ethanol engine would have a bigger range for the same amount of biofuel, and thus more convenient for car owners. This new type of ethanol engine can also be used in hybrid electric vehicles which would offer a quite different set of attributes to consumers than a conventional ethanol-only car. Therefore, the Brazilian ethanol supply chain should monitor, or even should contribute to the development of these new technologies, and analyzes the possible consequences for car owners and adapts the ethanol supply chain structure in order to avoid a repetition of the first setback in the 90s.

In monitoring the evolution of new ethanol consuming technologies and other relevant events, the ethanol supply chain should pay particular attention to the dynamics of supply and demand of ethanol. As we observed in both setbacks, once a new technology had been widely accepted by the consumers, the rate of increase in ethanol demand had been much higher than that of supply capacity. This fact had created the mismatch between demand and supply which was the root-cause of these setbacks. To expand ethanol supply capacity, a mill needs first to expand its sugarcane plantation and then to build new ethanol production capacity. These activities take at least three to four years. These differences in the dynamics of demand and supply need to be included in the planning of ethanol supply chain which requires a solid market and technology intelligence system in place.

The main limitations of this study relate to the characteristics of the sample: it consisted of a population from the Sao Paulo

state which is more well-educated people from the richest state of Brazil. Although we focus on São Paulo consumers, it is important to note that this is the main center of consumption of ethanol (hydrous and anhydrous) in Brazil. According to ANP (data from 2010), 25% of the total sales of gasoline C (that has ethanol) and 56% of the total sales of hydrated ethanol in the country is consumed in São Paulo.

Note that this paper did not aim to explore all the motives that could had caused the second set back, we believe that there are many causes, for instance effect of efficiency or inefficiency in the supply chain, food industry economy impact in the agriculture field, gasoline price, government regulation, impact of other derivatives of the oil in the market, etc. All these possibilities should be explored in future studies. Our objective here was to show that among many possible causes, one had been forgotten by the researchers: the consumers' preference. Related to our study, we also suggest that a longitudinal consumer preferences study could bring a good view in how driver act during oscillation prices. Hence, culture differences could also be explored since environmental cognitions are different in each country.

Conflicts of interest

The authors declare no conflicts of interest.

Appendix A. Semi-structure guide – Qualitative research

1. Do you have a car?
2. Which car do you have?
3. How did you choose to purchase this car?
4. Is your car a *flex* fuel model?
5. Why did you purchase a *flex* fuel model car?
6. What is your car for?
7. What is the date of your the last full fueled?
8. Describe how did you choose the type of fuel used.
9. Why did you choose this type of fuel?
10. How much gas/ethanol you still had on tank before full fueling it?
11. Which type of fuel did you used in your penultimate time? Why?
12. What factors influence you when you are buying fuel?
13. How do you think people usually select the type of fuel?
14. In what situations do you change your consumption routine.
15. What is your monthly expenditure on fuel
16. Demographics: gender, age, education, place of residence and marital status

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